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ALUMINUM RESEARCH

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ALUMINUM RESEARCH

LABORATORIES





FRONT VIEW OF ALUMINUM RESEARCH LABORATORIES

FROM THE DAYS when the research staff consisted of Charles M. Hall, the research work of Aluminum Company of America has constantly expanded. Founded on research and developed by research, the aluminum industry makes practical application of new scientific methods and discoveries in the commercial development of aluminum.

Aluminum Research Laboratories now occupy a modern laboratory building. In order to provide an atmosphere conducive to scientific work, the laboratory has been built on a 14-acre tract, overlooking the Alle-



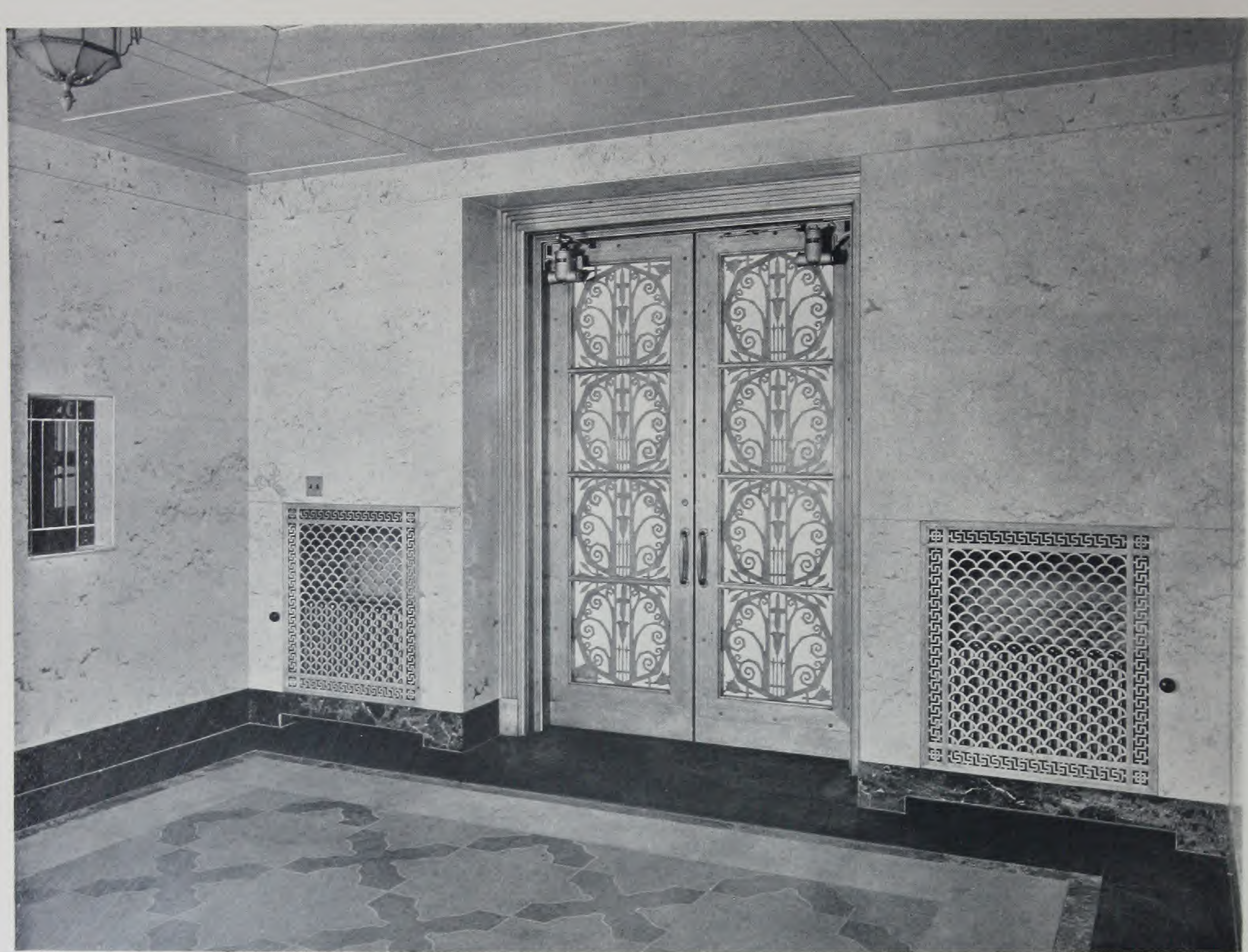


ENTRANCE TO ALUMINUM RESEARCH LABORATORIES

gheny River and amidst the foothills of the Allegheny Mountains.

The exterior of the building demonstrates some of the uses which are being made of aluminum in architectural decoration and construction. Approaching the main entrance, the eye is attracted by the aluminum doors with their cast aluminum grille work, framed by ornamental aluminum castings. Between the limestone pilasters, aluminum window frames are set with aluminum mullions and separated between floors by cast aluminum spandrels, decorated with blue and green vitreous enamel.

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ENTRANCE LOBBY EXECUTED IN MARBLE WITH ALUMINUM
DOORS AND FIXTURES

ENTERING THE LOBBY, one is struck by the color harmony of aluminum fixtures against white marble walls. The inlaid aluminum design in the green and white terrazzo floor harmonizes with the aluminum chandelier, radiator grille work, and wrought aluminum elevator doors. The same motif employed in the design of the chandelier in the lobby is used in the lighting fixtures for the Conference Room, which is on the same floor. This room, paneled in oak, natural finish, provides a meeting place for staff conferences and groups of visitors to the laboratory.





ALUMINUM FURNITURE IN THE CONFERENCE ROOM
PANELED IN OAK

The blue upholstery provides a striking contrast with the natural finish of the aluminum furniture, which is also set off by the deep blue background of the rug. Aluminum chairs, light, durable and fireproof, are used in offices and laboratories.

The research activities of the staff of 150 are grouped in seven divisions,—Metallurgical, Physical Testing, Chemical Development, Analytical Chemistry, Physical Chemistry, Patents, Paints and Finishes Divisions. Small staffs are maintained at several of the plants of the Company.

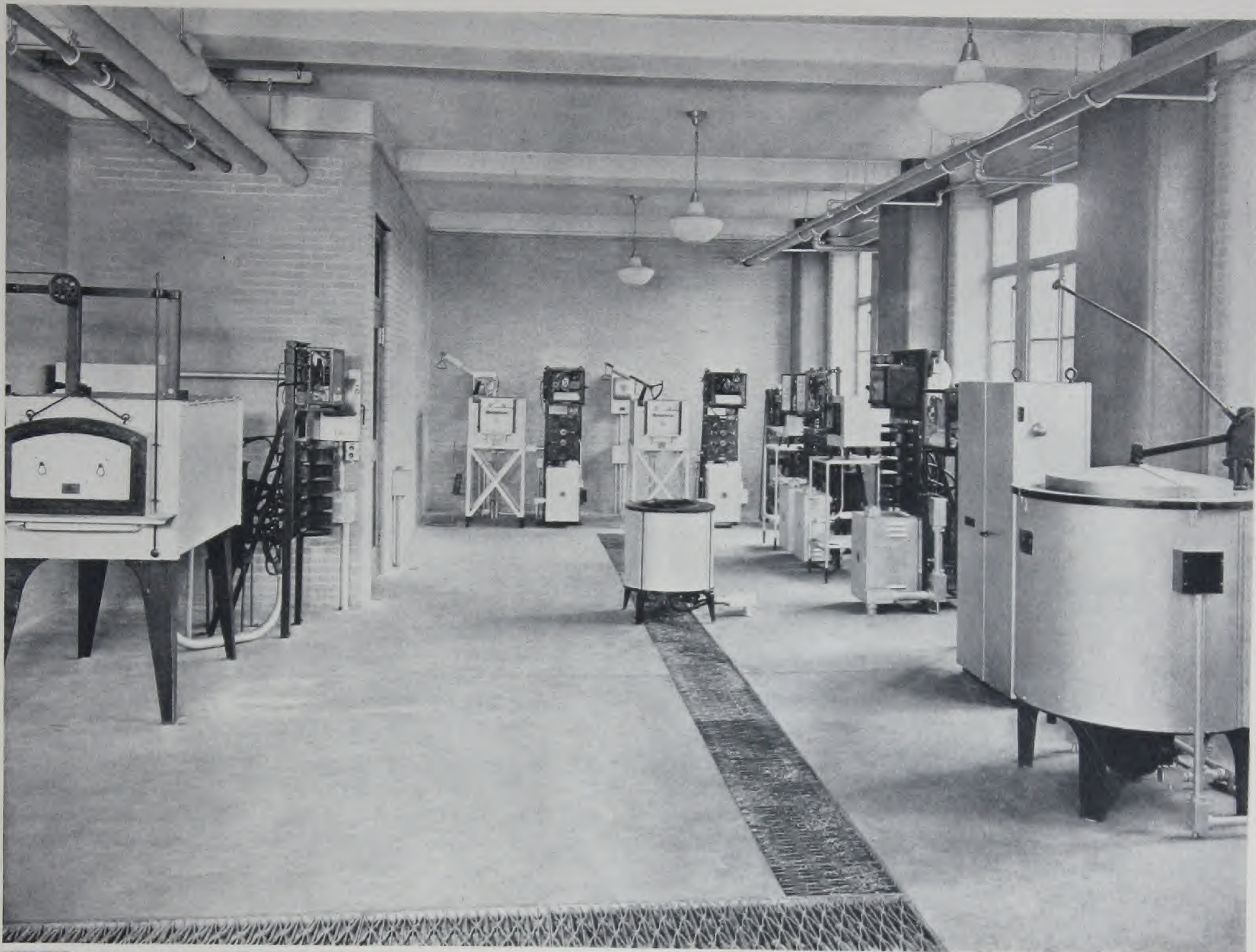


V I E W O F E L E C T R I C M E L T I N G A N D R O L L I N G E Q U I P M E N T I N
M E T A L L U R G I C A L L A B O R A T O R Y

RESEARCH in the metallurgy of aluminum is one of the principal activities of the laboratories. Thorough scientific investigations of the fundamental properties of aluminum and its alloys lay the foundation for the practical development of new alloys and the improvement of old.

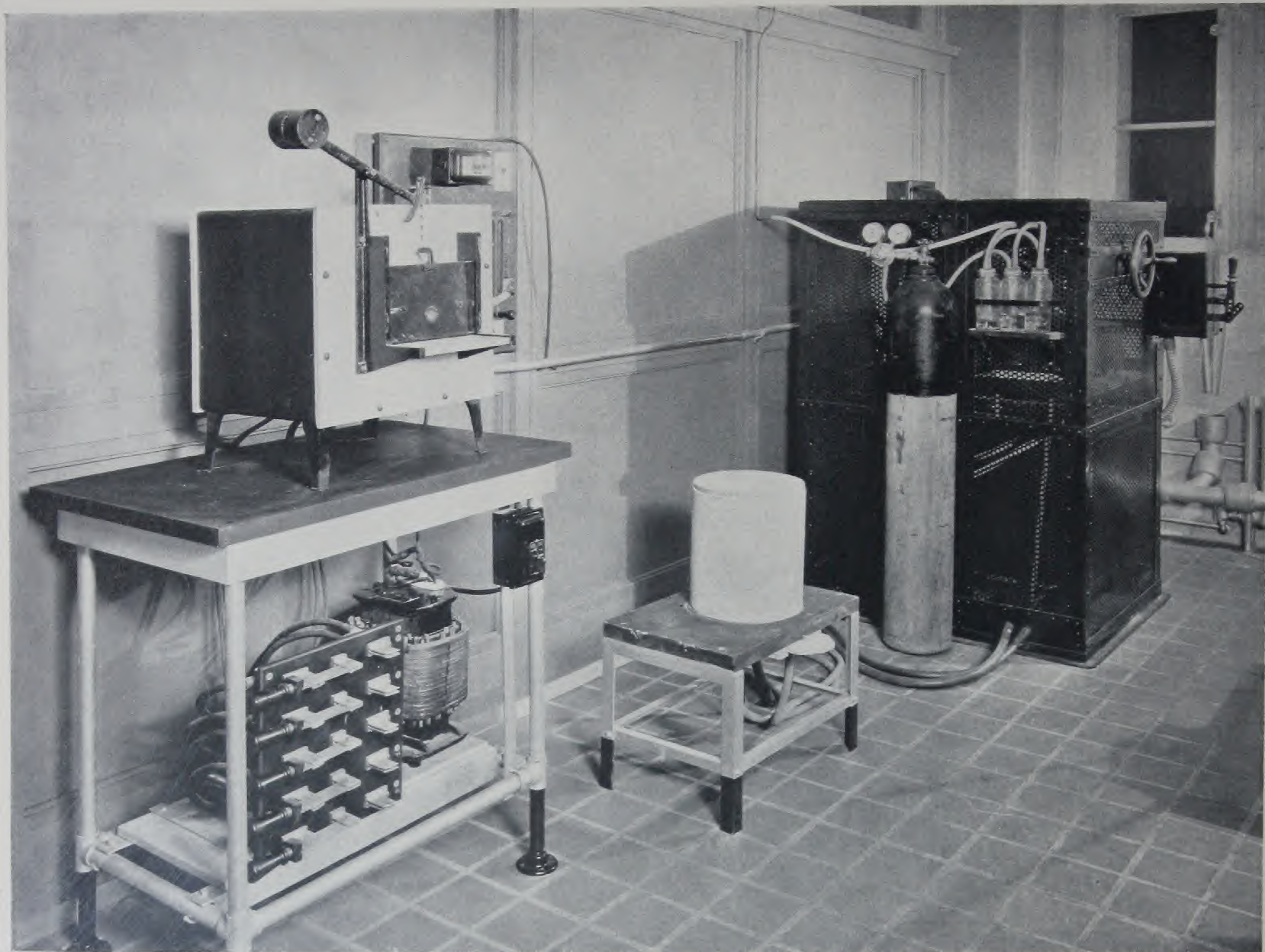
Equipment for experimental melting, casting and rolling of aluminum alloys is located in large laboratories on the ground floor. Heat treatment of aluminum alloys has greatly extended their utility and a variety of types of electrically-heated furnaces are provided for this pur-





ELECTRIC FURNACES AND HEAT-TREATMENT EQUIPMENT IN
METALLURGICAL LABORATORY

pose. The metallographic investigation of aluminum alloys also frequently requires long-time heat treatment operations in order to produce structural equilibrium. Smaller furnaces, with accurate temperature control equipment maintaining constant temperatures for periods of several months, are used. The temperature at any furnace may be accurately ascertained by means of a centrally located precision potentiometer. The progress of structural changes produced by heat treatment and aging is revealed by precise measurements of electrical conductivity.

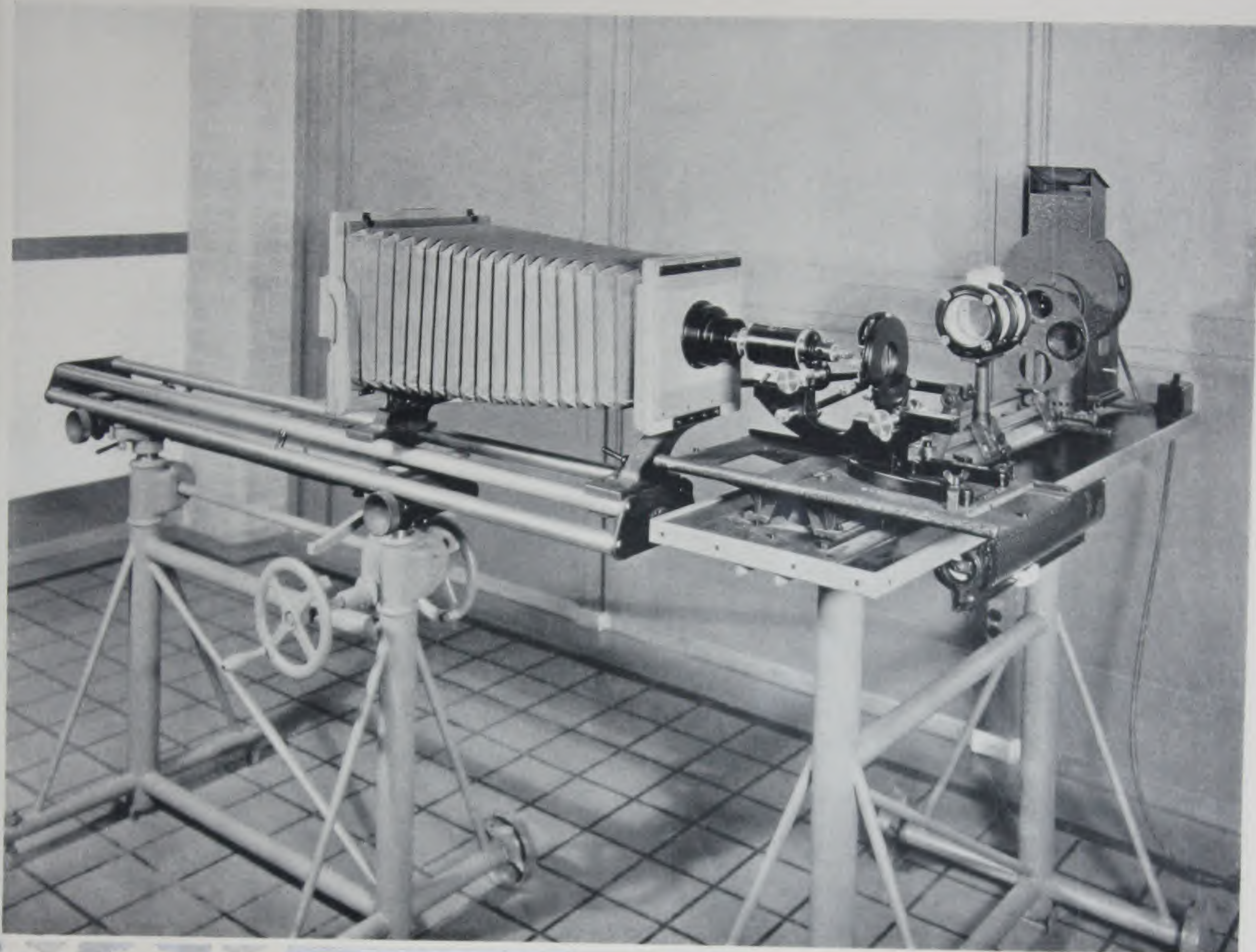


HIGH-FREQUENCY INDUCTION FURNACE WITH SMALL MUFFLE FURNACE AT LEFT

FOR THE attainment of very high temperatures, a 15 KVA high-frequency induction furnace is available in the Physical Chemistry Laboratory. With this furnace, high temperature experiments can be carried out in vacuo and temperatures as high as 5400° Fahrenheit are readily attainable. The small muffle furnace operates at temperatures up to 2000°.

To the study of metals and alloys are brought the tools of science, such as the microscope, the X-ray, the spectroscope, the potentiometer and many other instruments. The X-ray is employed to investigate de-

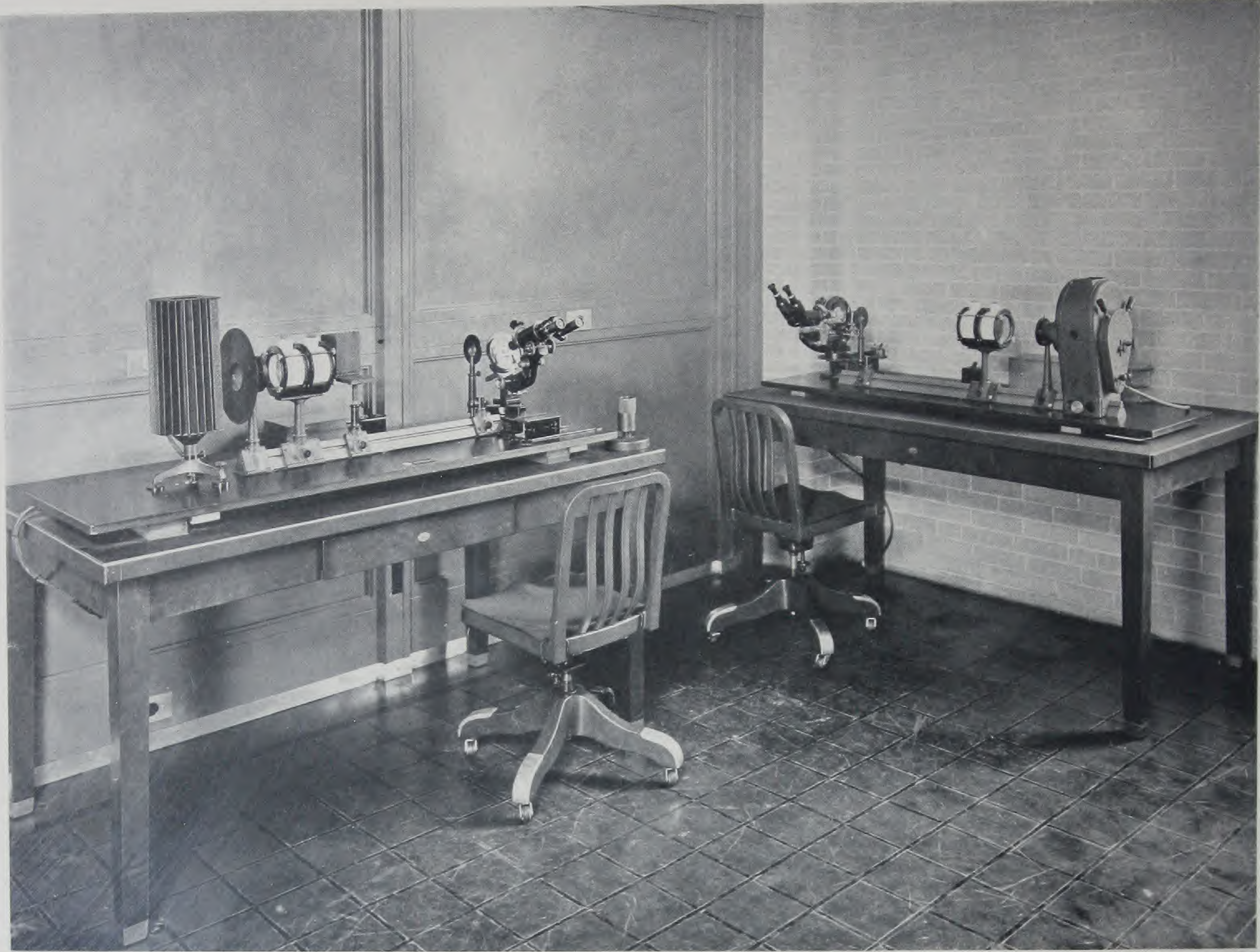




MICROSCOPE FOR THE PHOTOGRAPHY OF METAL STRUCTURES

tails of metal structure which are beyond the power of the microscope to reveal. The spectroscope reveals elements in an alloy which are present in too small amounts to be determined by ordinary chemical methods.

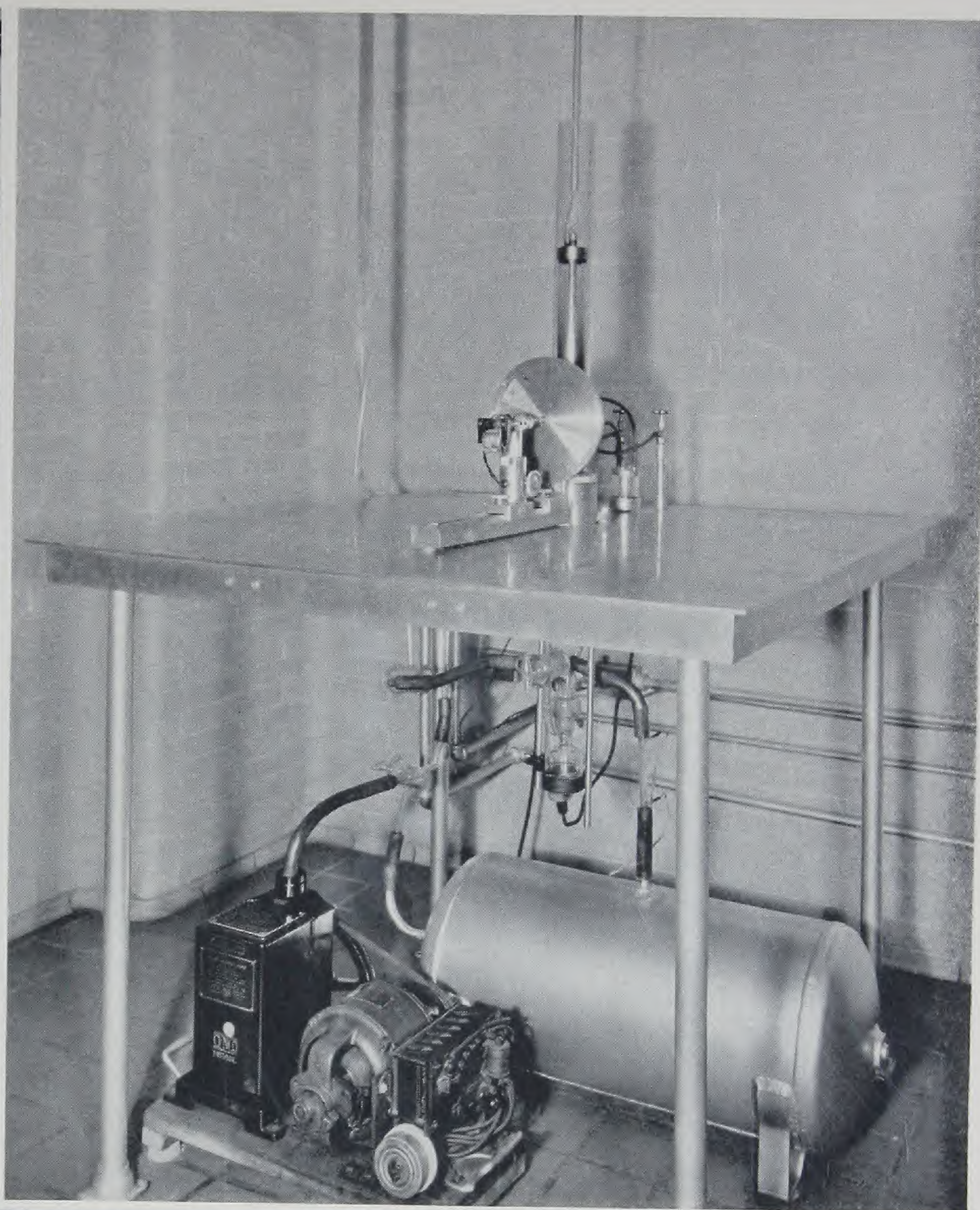
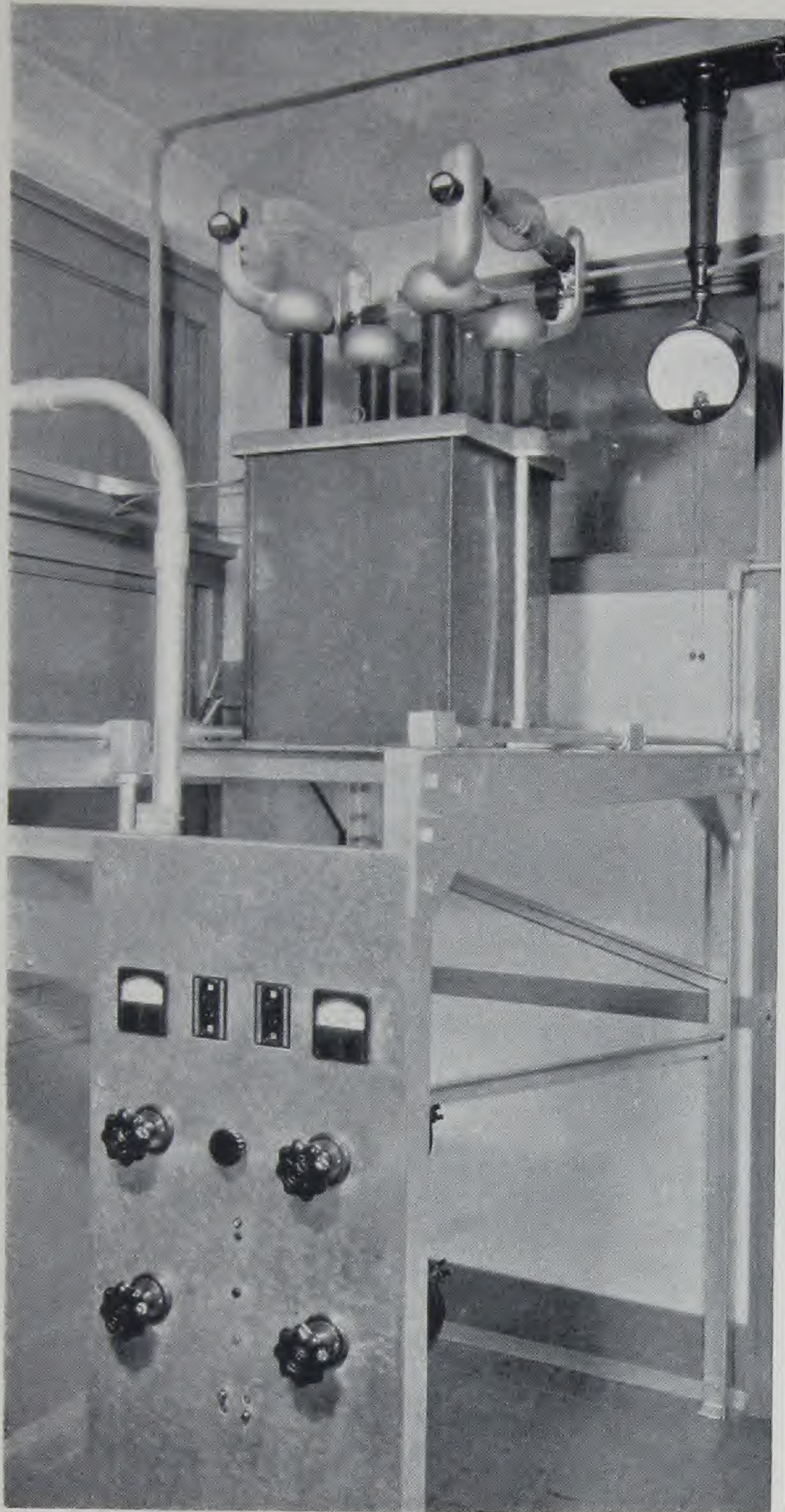
Microscopic examination is indispensable in metallurgical research, for while chemical analysis ascertains the total composition of an alloy, the microscope indicates the manner of occurrence of the alloying elements. The microscope is also important in diagnosing manufacturing troubles and insuring a product free from defects.



MICROSCOPES FOR VISUAL EXAMINATION OF METAL STRUCTURES

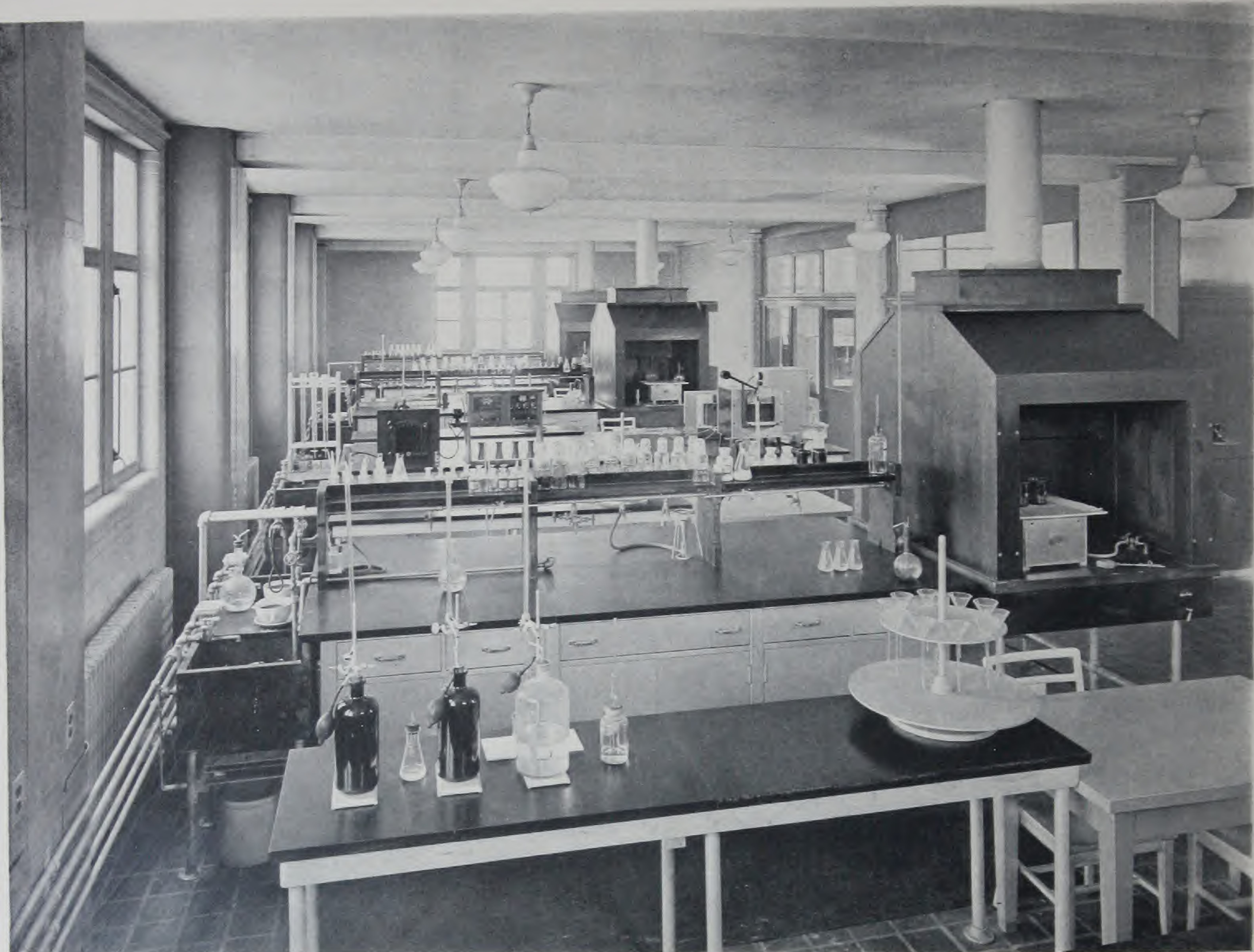
POWERFUL MICROSCOPES of the type shown are used for detailed study of metals, and photomicrographs recording structures of special interest are made on instruments capable of magnifications as low as 5 diameters and as high as 16,000. The motifs for the cover and page decorations in this book are found in the many fantastic structures which the microscope reveals in aluminum and its alloys. The decoration on page 14, for example, is based on a photomicrograph of an aluminum-silicon alloy, on page 15, of an aluminum-copper alloy.





POWER SUPPLY (LEFT) AND X-RAY TUBE (RIGHT) WITH
VACUUM PUMPS BENEATH TABLE

X-rays provide an "eye" that can tell us many things about the inside of metal crystals, such as the arrangement and spacing of atoms within the crystal, grain orientation and size, and extent of internal strain. In the picture, X-rays generated within the long glass tube in the center of the table are being reflected from the layers of atoms within the crystals in a sheet of aluminum, and the diffraction pattern photographed. The X-ray is also used in radiography to ensure the absence of structural defects, and as a guide in developing the best casting practice.

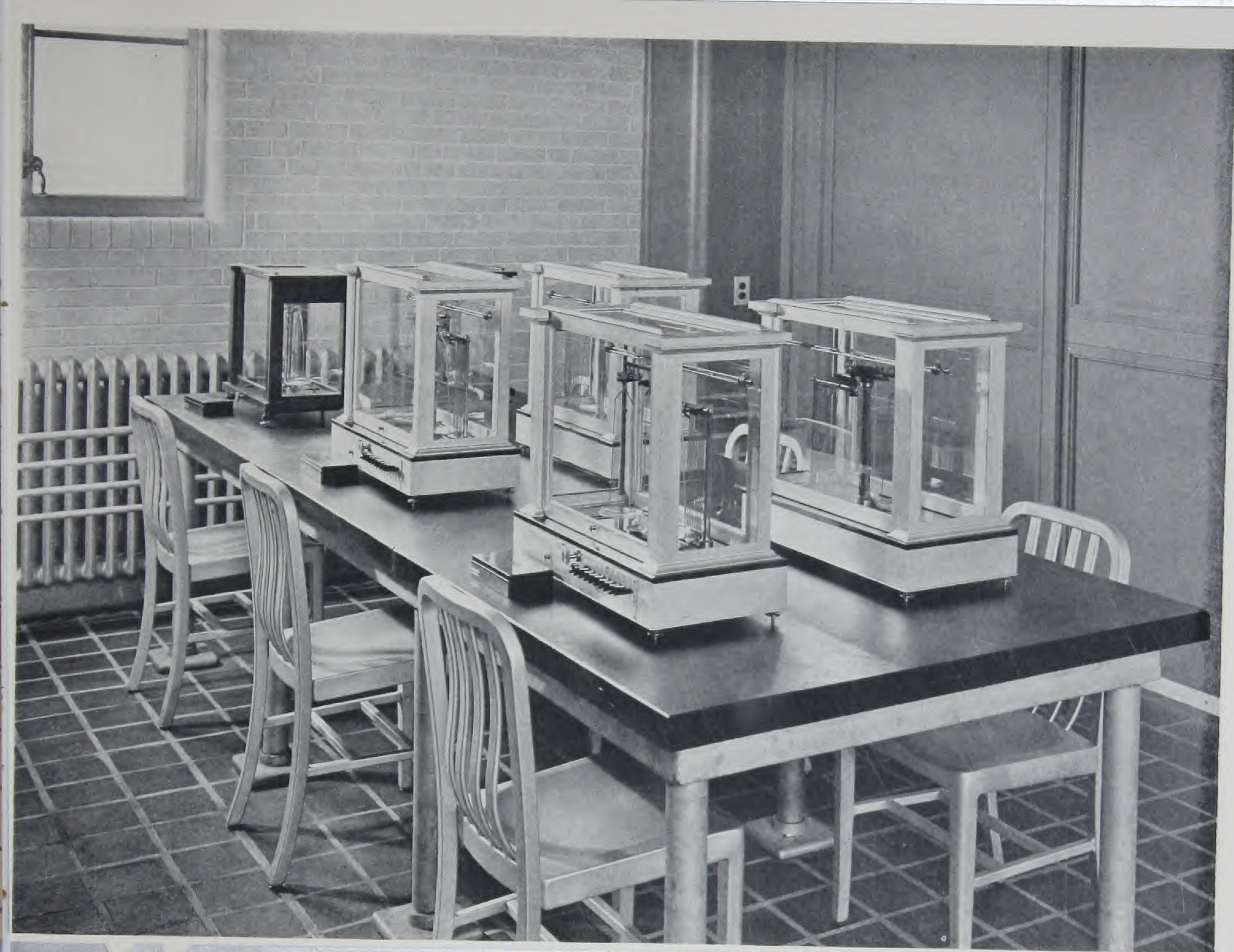


CHEMICAL LABORATORY FOR THE ANALYSIS OF METALS

THE determination of the chemical characteristics of materials, including composition, is essential to research. In the several laboratories devoted to such work are to be seen a variety of applications of aluminum in laboratory equipment, such as benches, tables, hood supports, filter racks, hot plates, chairs, drawer pulls, hinges and aluminum-encased balances. The chemical benches, made of corrosion-resistant aluminum with soapstone tops, are an innovation in laboratory equipment.

Aluminum equipment is extensively used by industry in combating





PRECISION BALANCES USED IN CHEMICAL ANALYSIS

chemical corrosion, and a laboratory is devoted to investigating the serviceability of aluminum for many such applications. The packaging of foods, drugs and sundry products in aluminum presents problems which come to these laboratories for investigation.

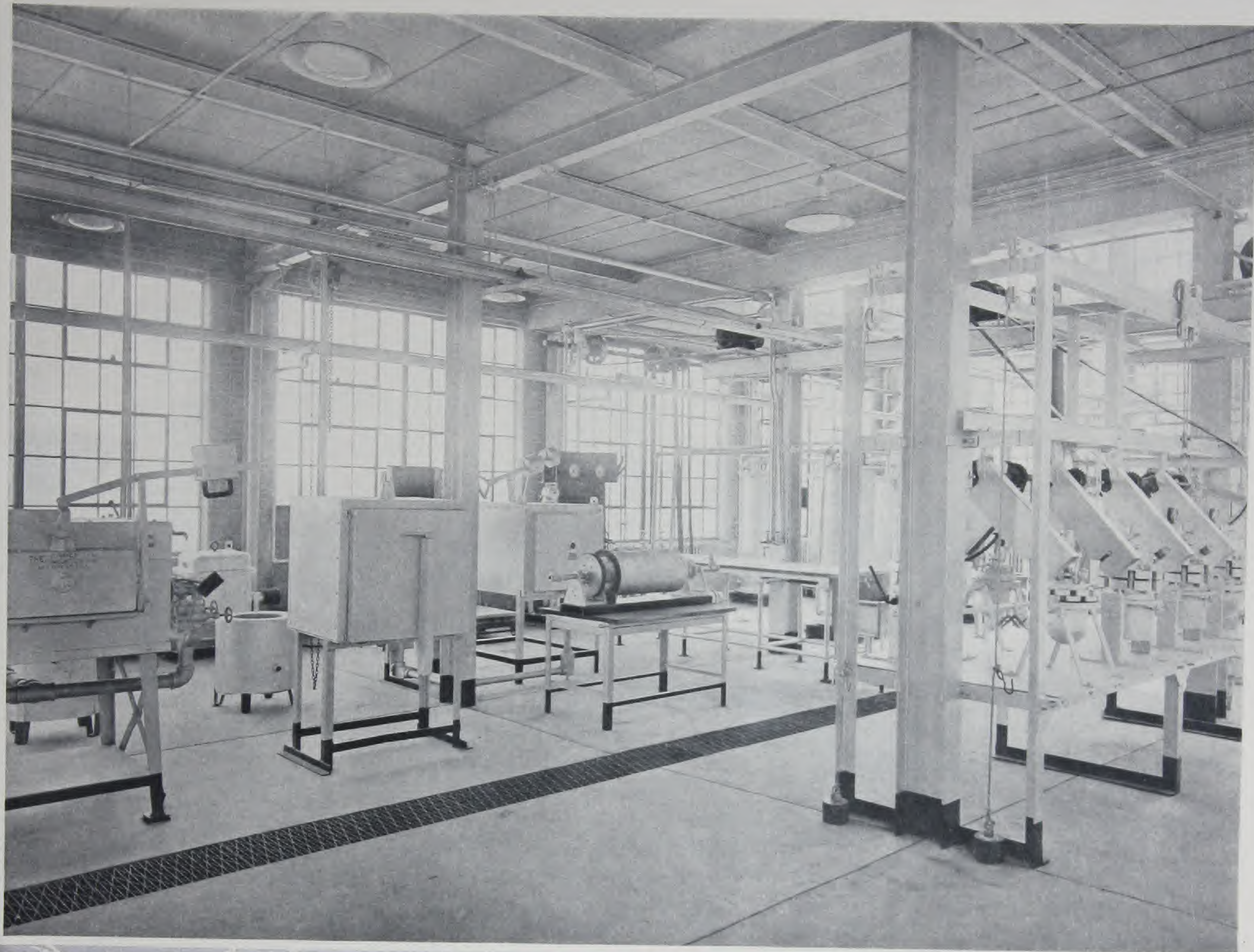
Here also is done the essential work of establishing and maintaining Alcoa Standard Analytical Methods which are used in company-controlled laboratories and made available to other laboratories through publication.



LABORATORY FOR SPECTROGRAPHIC ANALYSIS OF MATERIALS

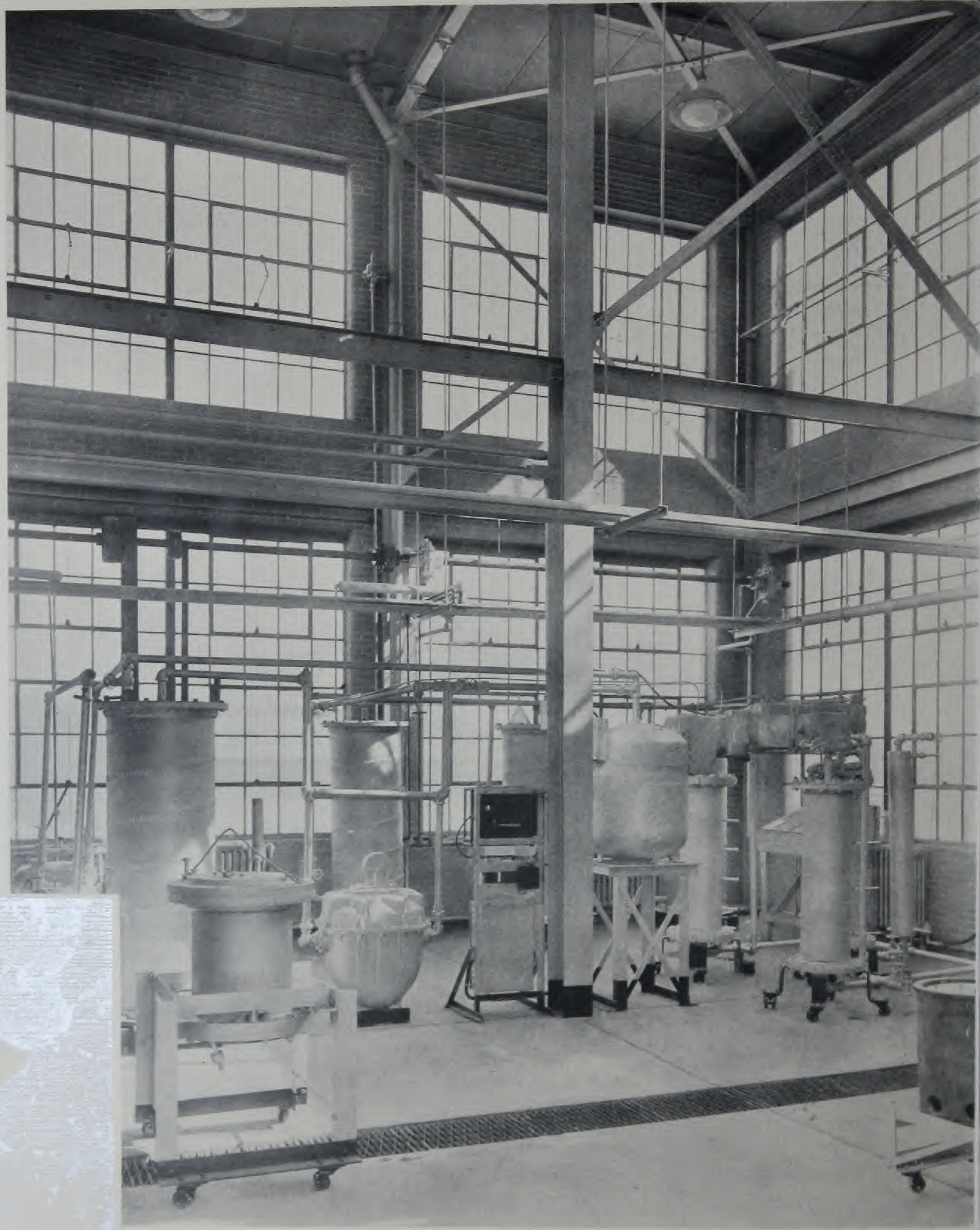
THE SPECTROGRAPH is an indispensable aid to the research chemist. With speed and certainty the composition of any metal can be determined qualitatively by vaporizing samples of the metal by arc or by spark and recording the spectrum photographically. Since most of the sensitive spectral lines occur in the ultra-violet region, the spectrograph shown has a quartz optical system which readily transmits ultra-violet radiation. Quantitative results are obtained by comparing, by suitable methods, the photographed spectral lines with the lines produced by standard samples.



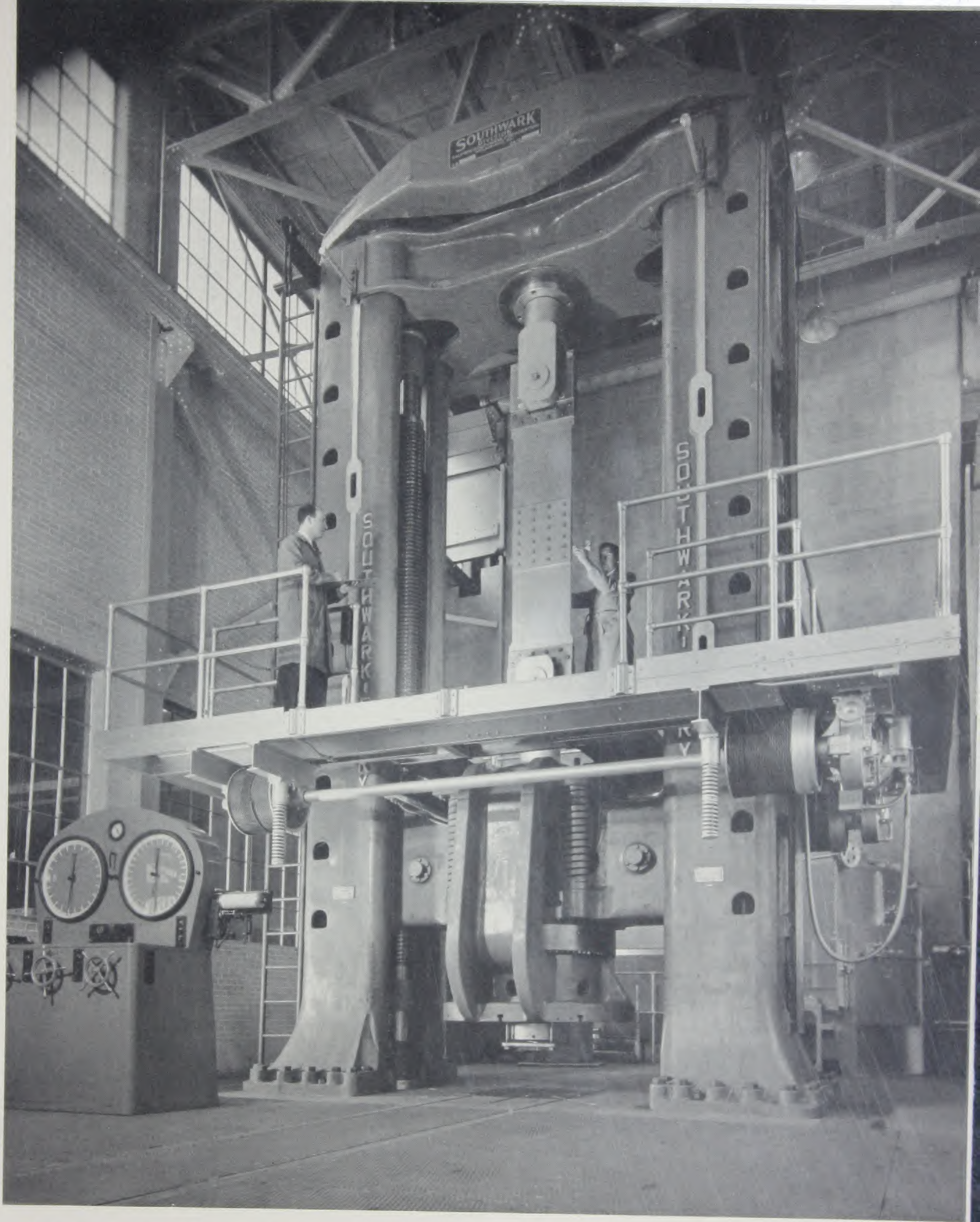


LABORATORY FOR LARGE SCALE CHEMICAL PROCESS
DEVELOPMENT WORK

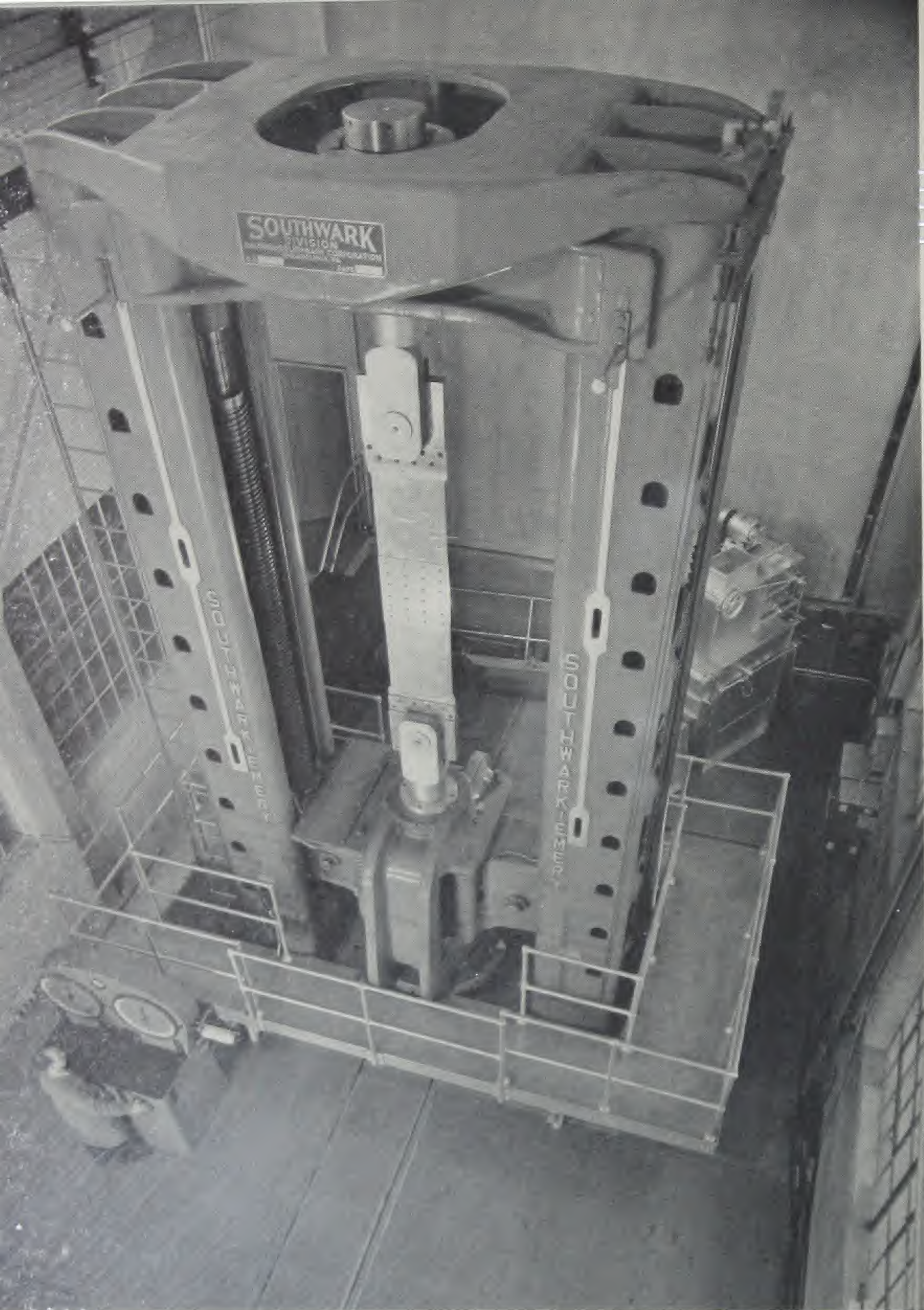
Chemical process development work is carried out in a large laboratory in the rear court of the building. In these laboratories are a variety of ovens, gas-fired and electrical furnaces; pressure digesters; crushing, grinding and pulverizing machinery; sieves and classifiers. The rear of the laboratory (shown on the next page) is two stories in height, thus permitting the use of full size test units of most plant equipment. The apparatus shown on page 16 is used to measure the moisture absorption efficiency of activated alumina, a product of research.



LABORATORY WITH EXTRA HEIGHT FOR CHEMICAL PROCESS DEVELOPMENT WORK



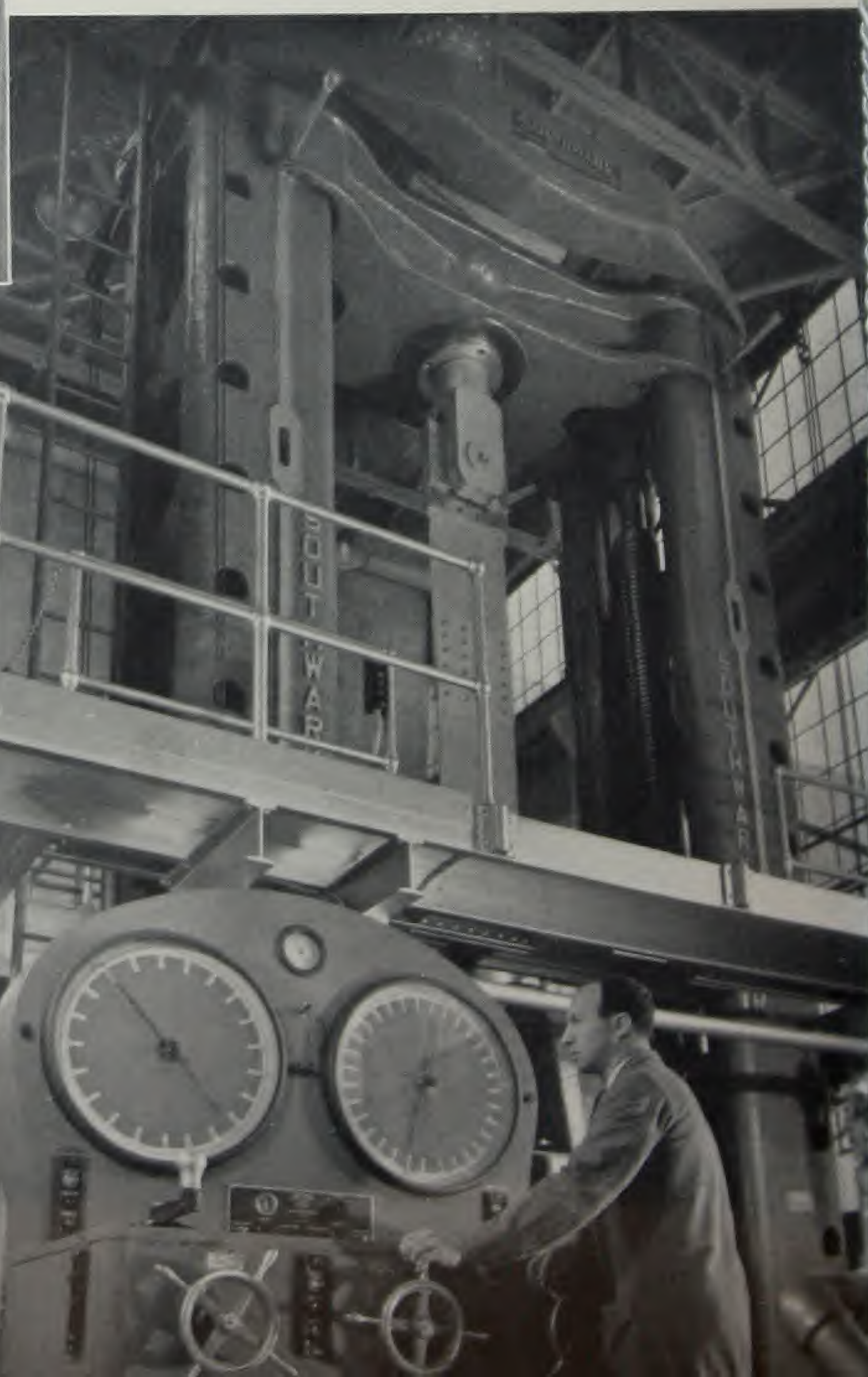
The new universal precision metal-working machine. Capacity: 3,000,000 lb. in compression, 1,000,000 lb. in tension. The ability to move the head of the machine at speeds as high as 36 inches per minute under full load makes this the most powerful machine of its kind in the world.

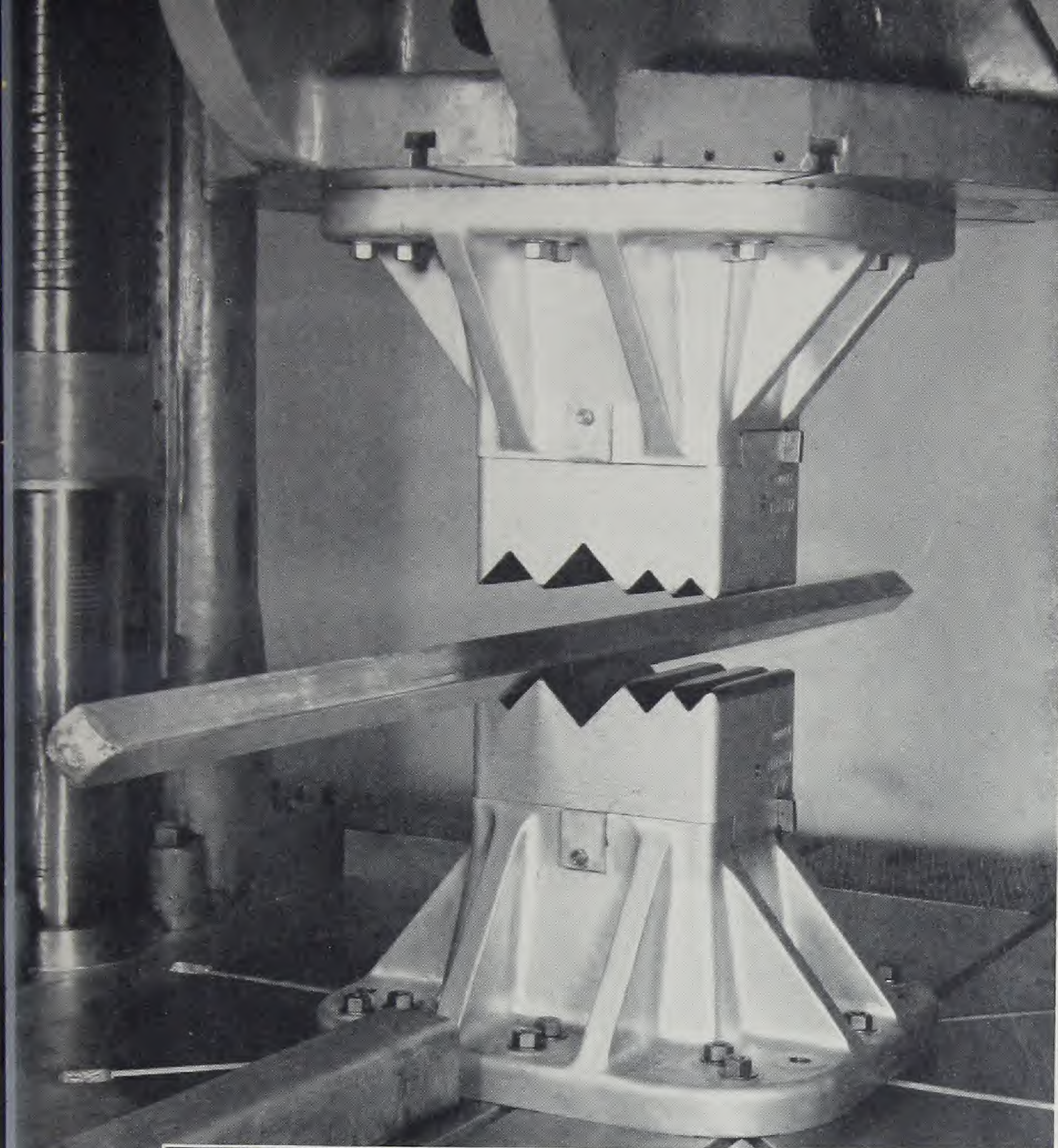


LEFT—Tensile test: a large riveted joint specimen in the machine.



BELOW—The control unit of the machine.



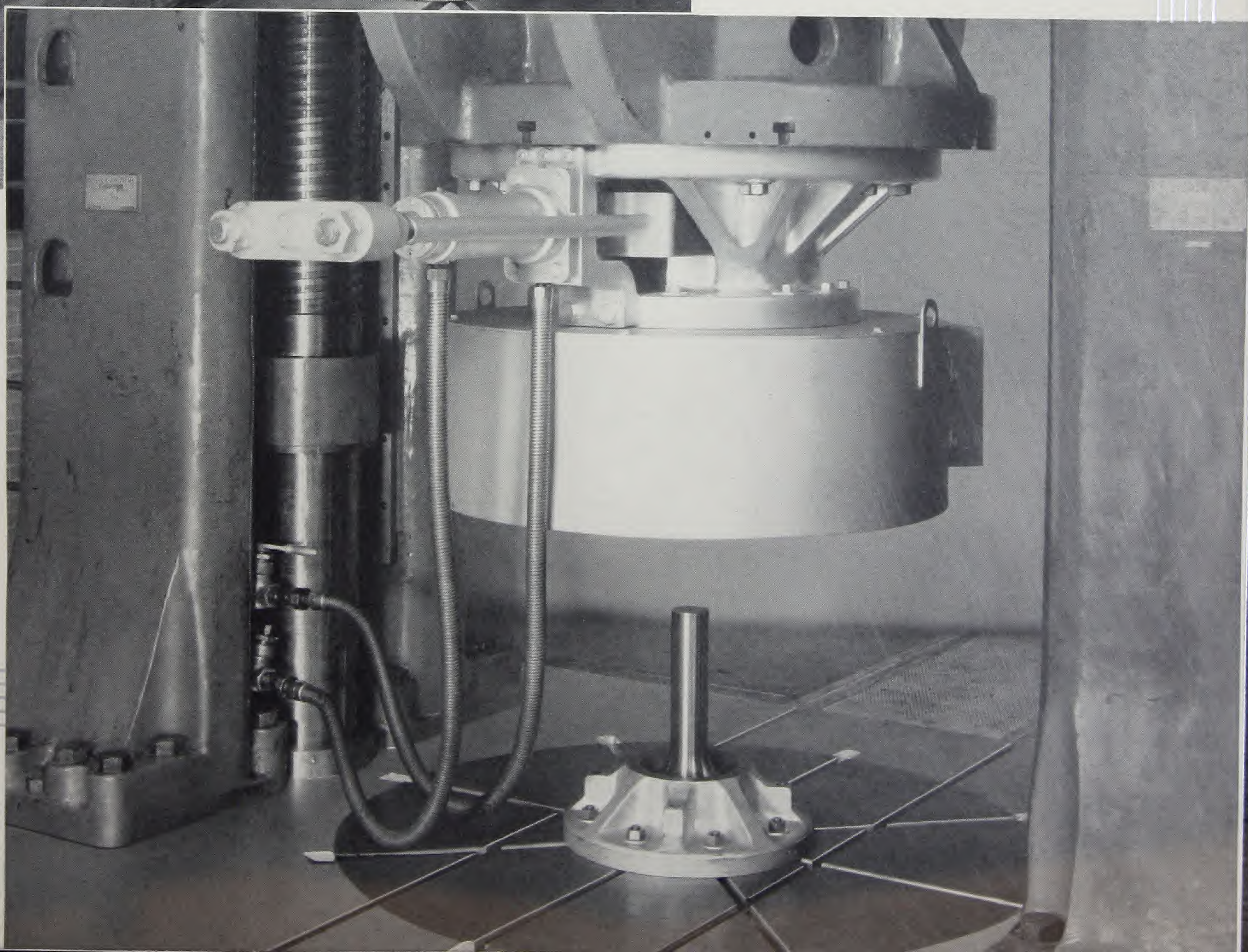


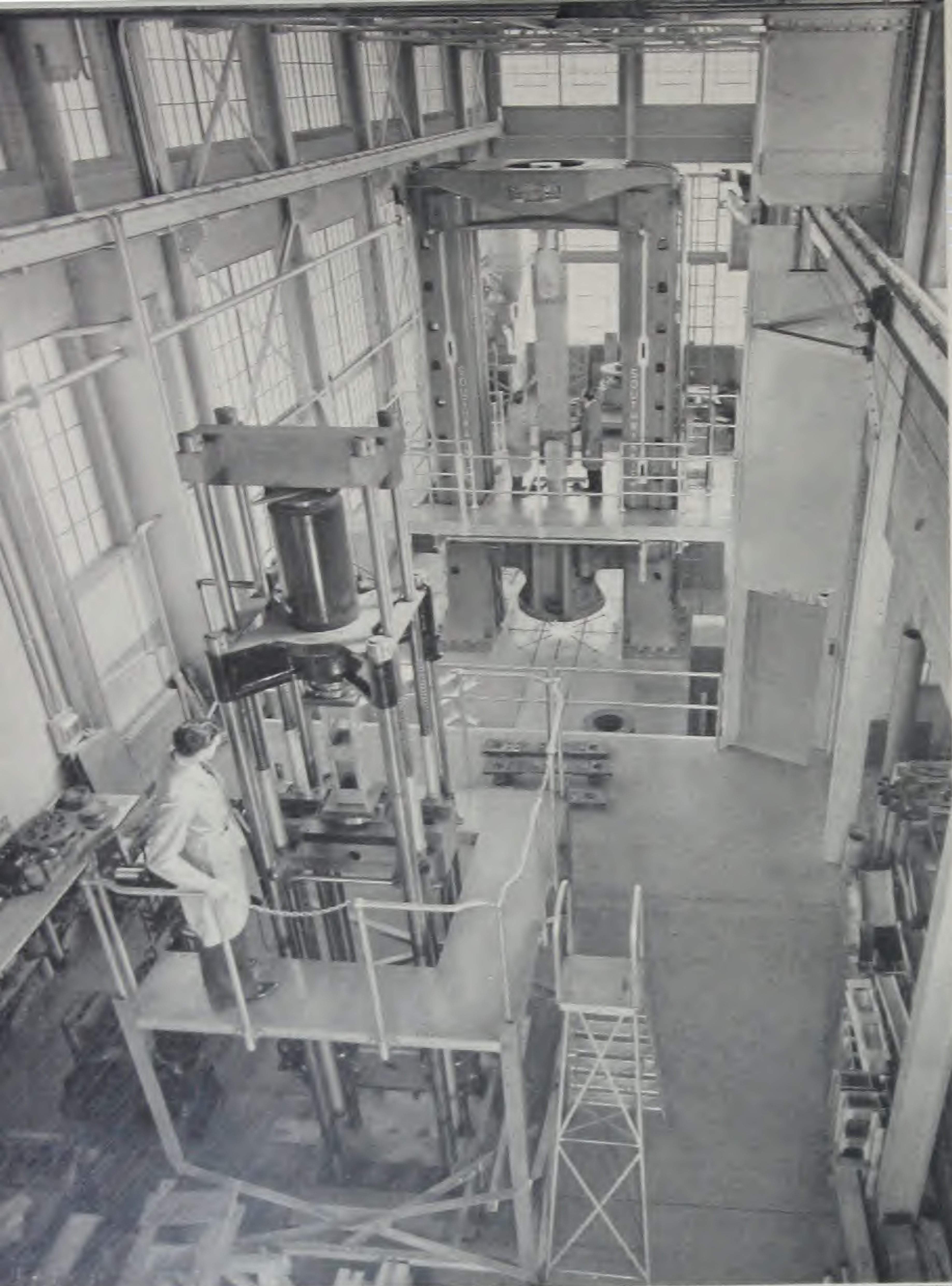
LEFT—Press forging an
aluminum ingot.

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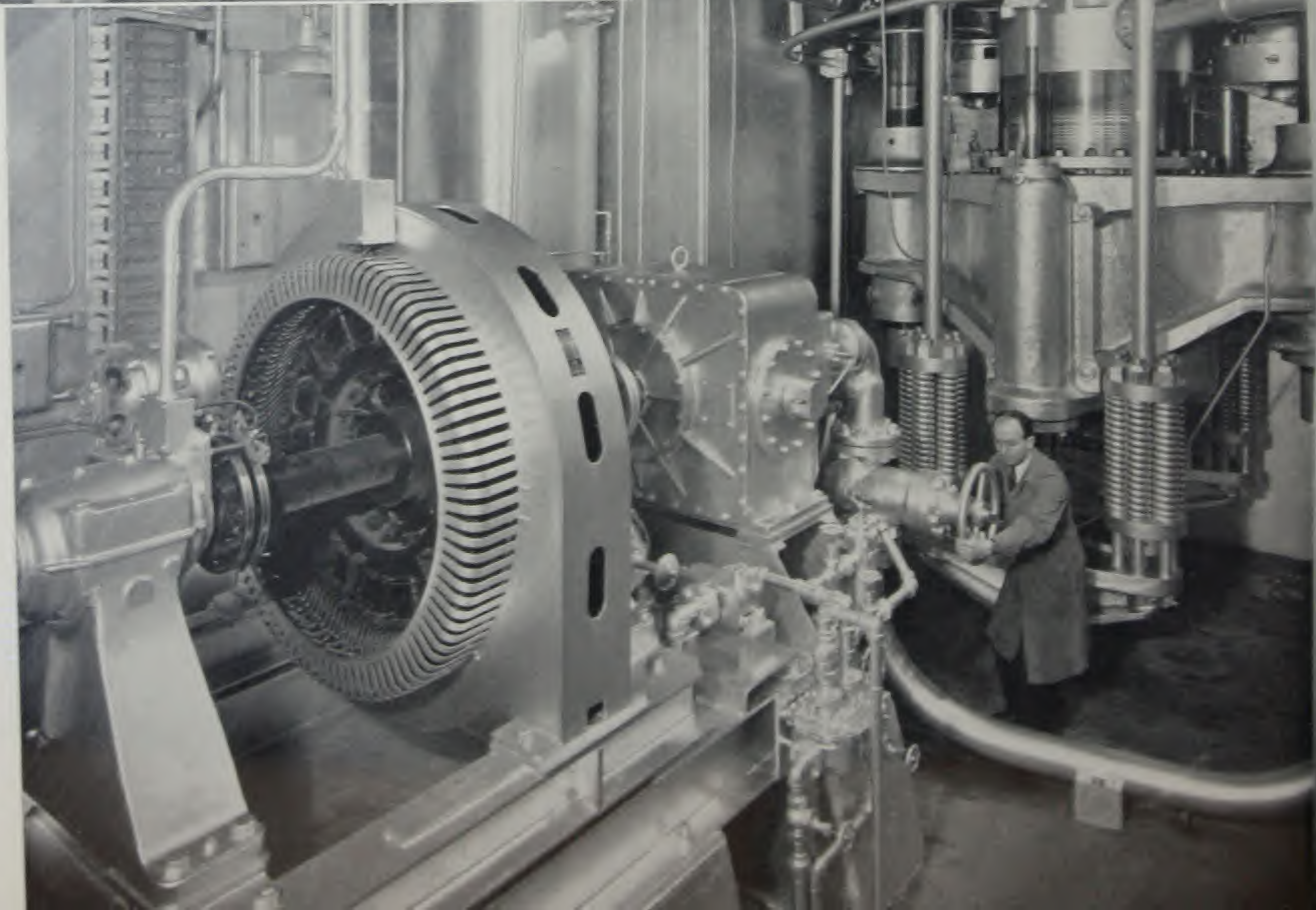
BELOW—Electrically heated
extrusion equipment.

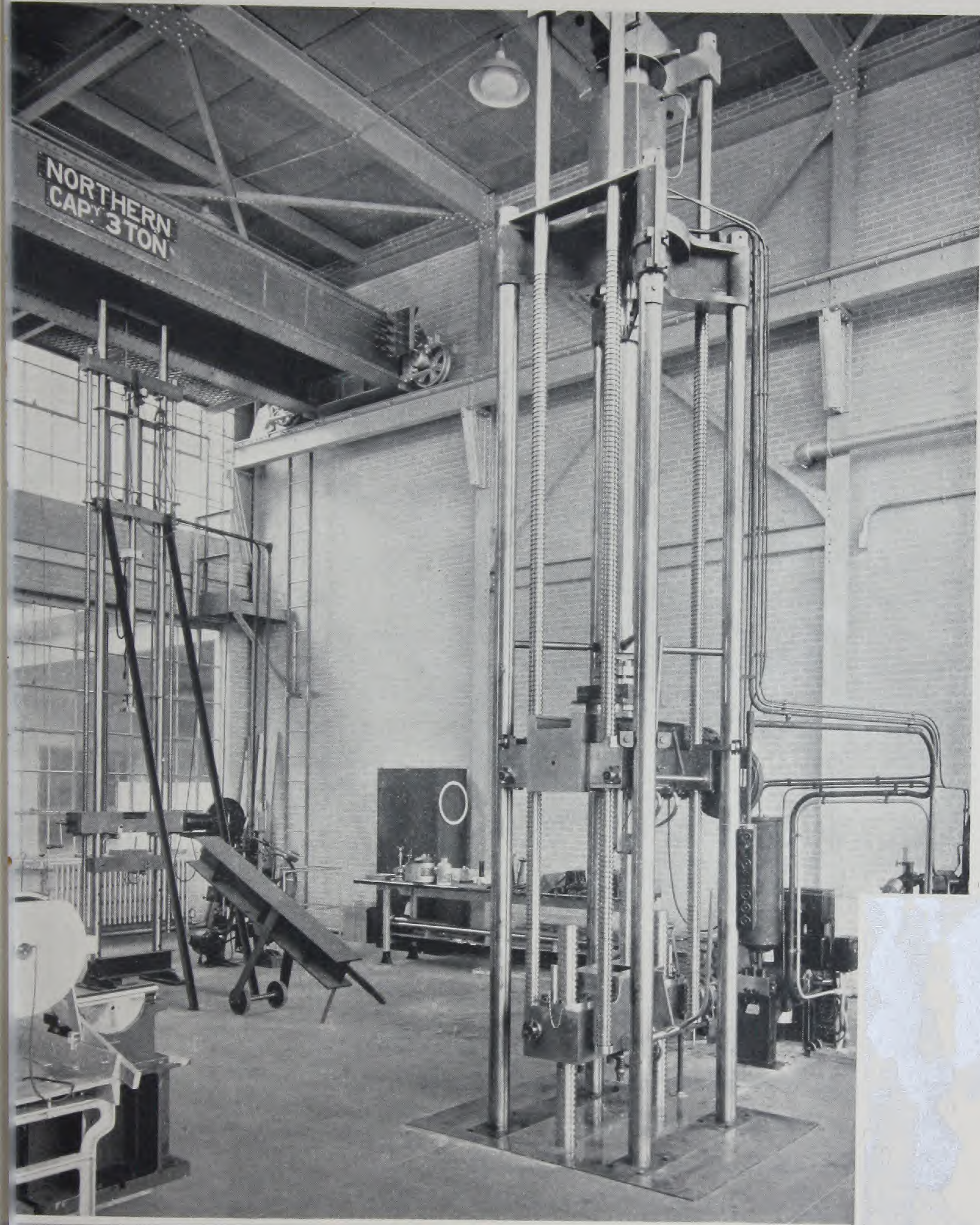




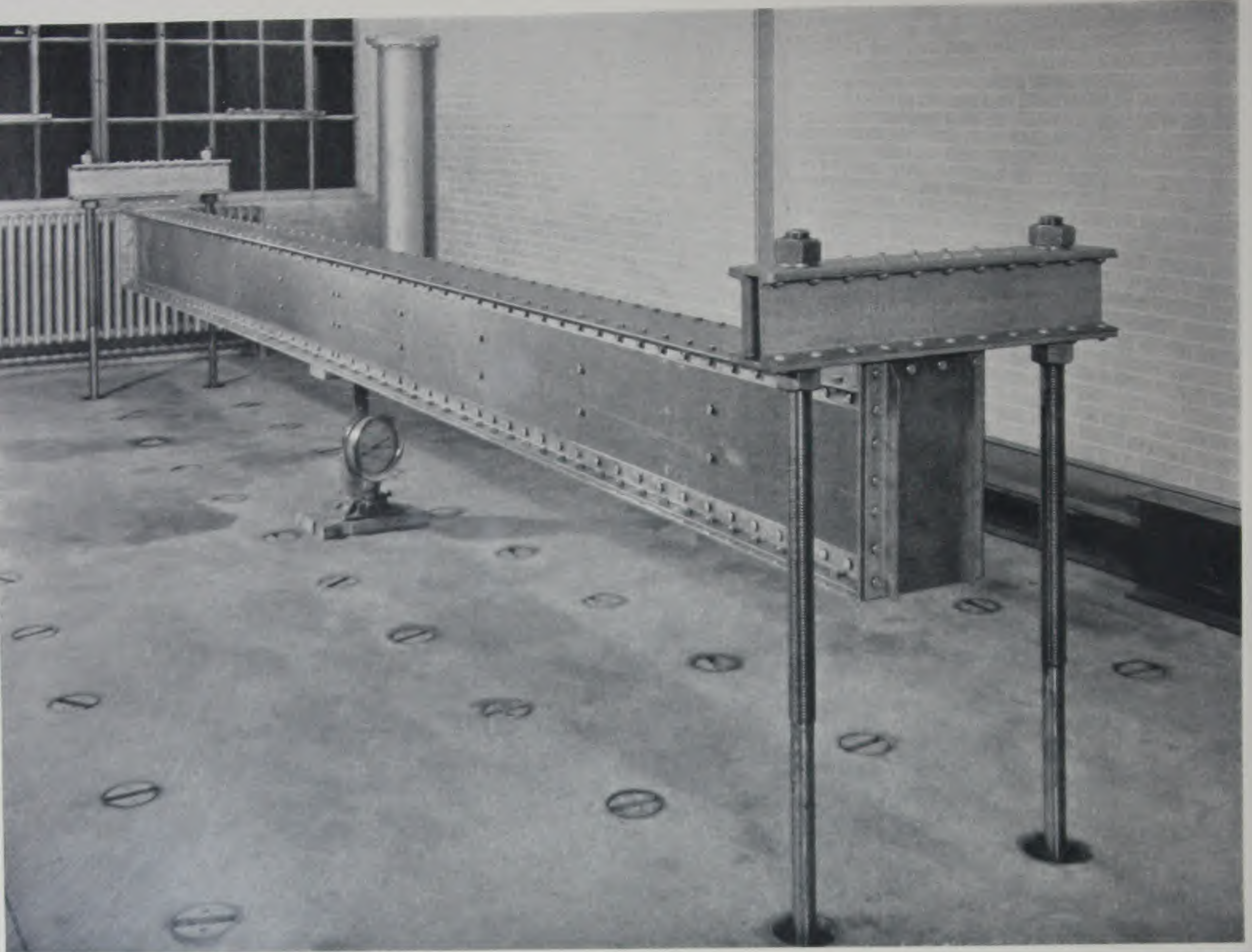
LEFT—Testing laboratory, showing the 300,000 lb. and the 3,000,000 lb. machines.

BELOW—The operating machinery is located below the floor. The oil pump and the 300 hp. motor furnish power to the large machine through the hydraulic cylinder.





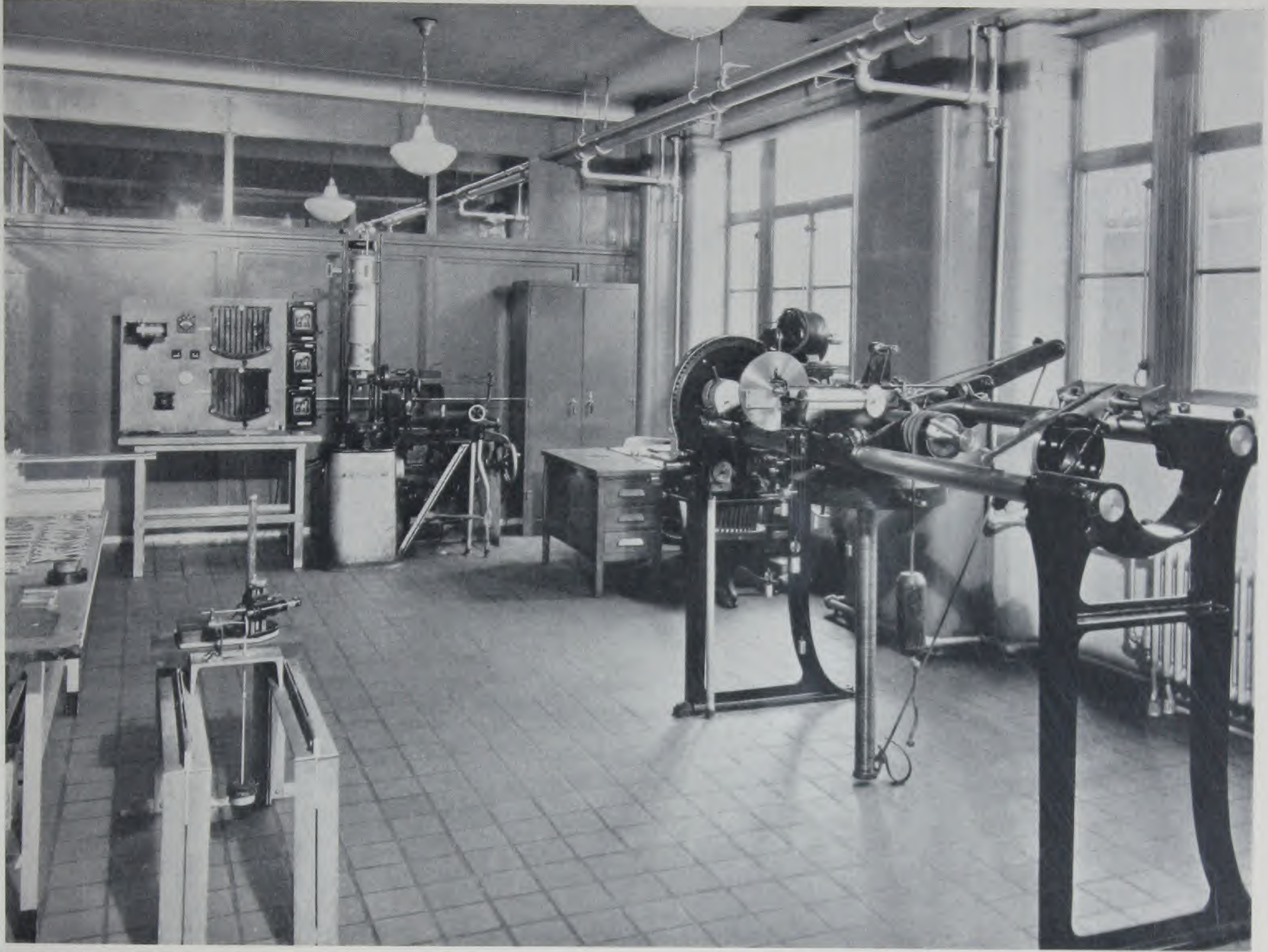
LEFT—AMSLER UNIVERSAL TESTING MACHINE WITH 7 CAPACITIES FROM 400 TO 40,000 POUNDS
 RIGHT—AMSLER UNIVERSAL TESTING MACHINE WITH 4 CAPACITIES FROM 30,000 TO 300,000 POUNDS



UNIVERSAL FLOOR TEST SLAB; ALUMINUM ALLOY GIRDER IN POSITION FOR TEST WITH 30-TON HYDRAULIC JACK

THE LABORATORIES are exceptionally well equipped with testing equipment for the accurate determination of the mechanical properties of metals as well as the strength of fabricated units and structures. The equipment includes a four range 300,000-lb. maximum capacity Amsler hydraulic universal testing machine, taking tension or compression specimens up to 10 feet in length, or beams with a maximum span of 10 feet. A somewhat smaller machine has seven capacities ranging up to 40,000 pounds. These machines are served by a 3-ton aluminum alloy crane.

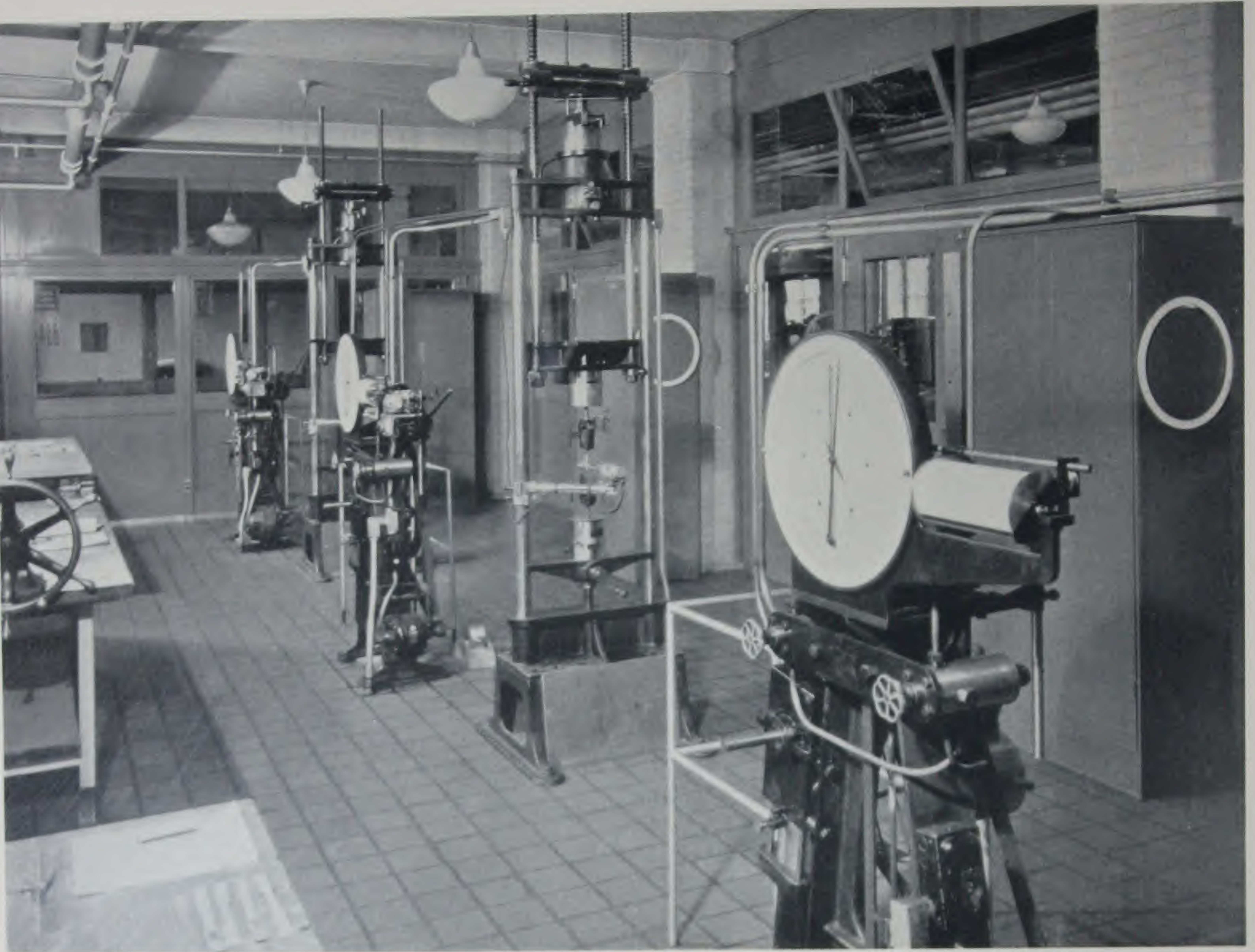




AMSLER TORSION TESTING MACHINE

Adjacent to these machines is a Universal floor test slab, consisting essentially of a reinforced concrete beam 12 feet by 30 feet, the upper surface flush with the floor. In this beam are 48 inserts each capable of withstanding a pull of 30 tons. By the use of suitable tension bolts and cross members, accurately calibrated hydraulic jacks with capacities up to 75 tons are used in testing girders, trusses, car frames, truck frames, etc.

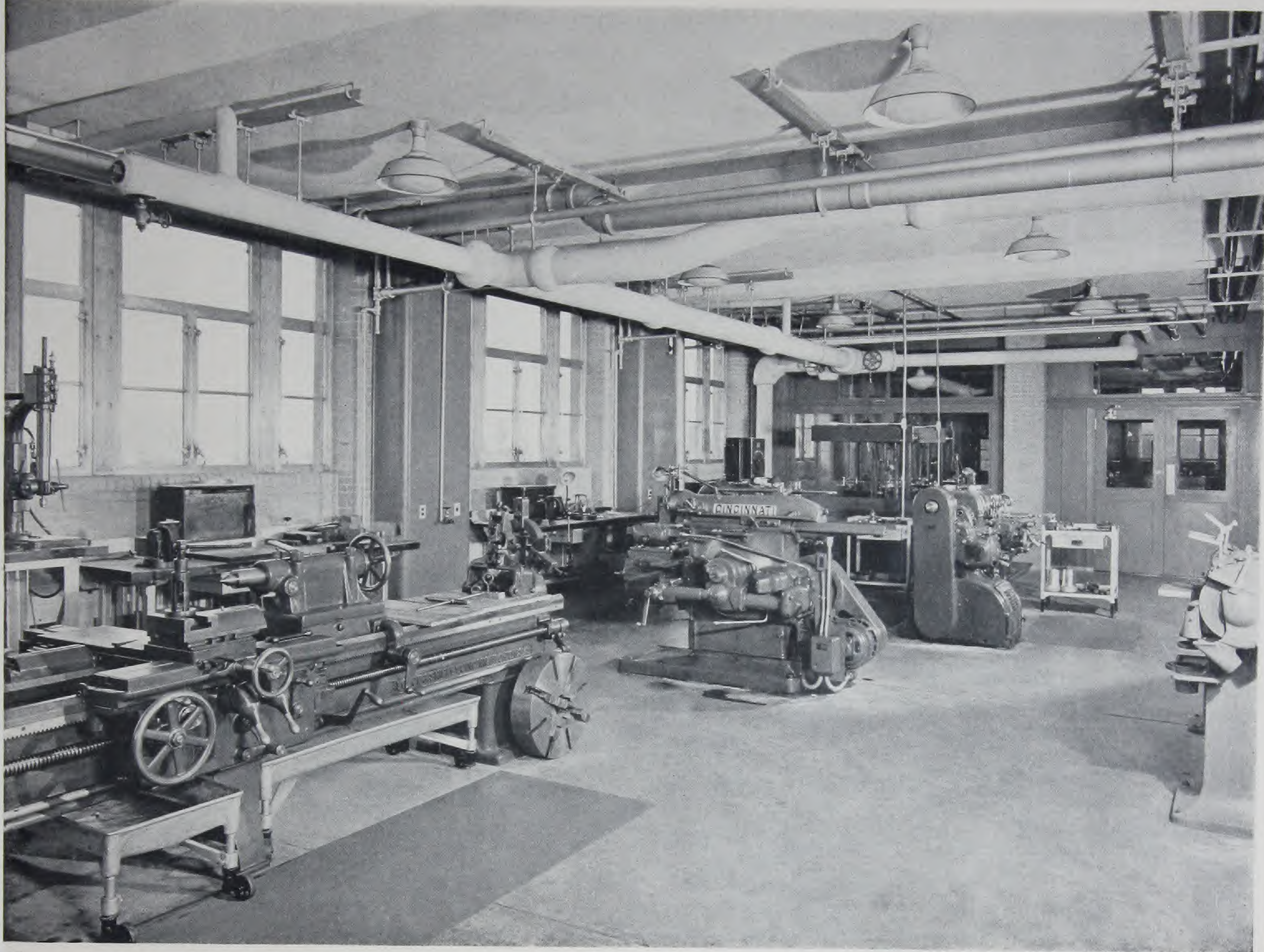
The Amsler torsion testing machine has four capacities ranging from 240 to 1200 foot-pounds, and handles specimens as long as 4 feet.



UNIVERSAL TESTING MACHINES WITH AUTOMATIC
ELECTRIC RECORDING EXTENSOMETERS

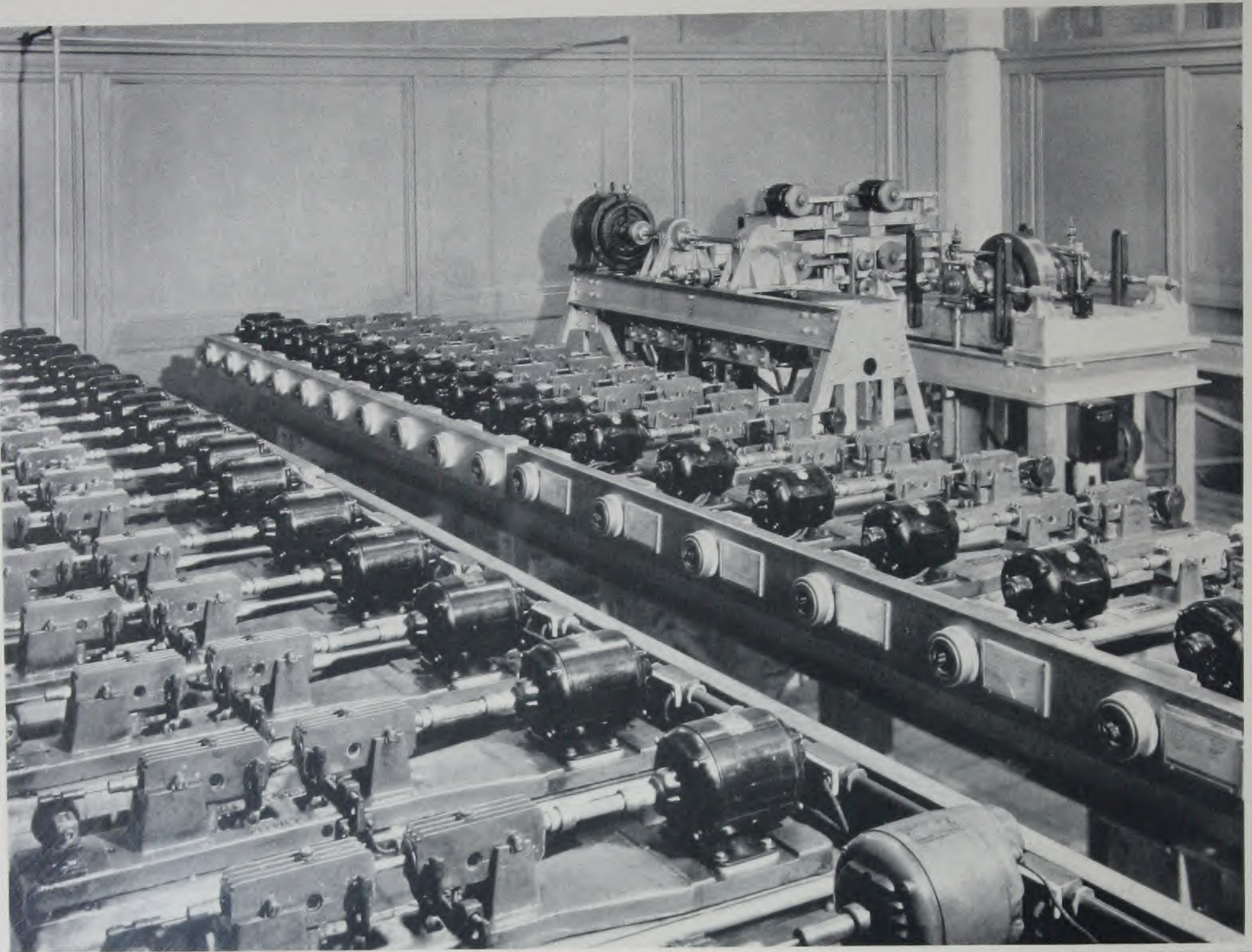
FOR the determination of the tensile and compressive properties of aluminum products, the laboratories are further equipped with smaller Universal testing machines. These machines include three Amsler hydraulic Universal machines, each having seven capacity ranges of 200 to 20,000 pounds, and two Olsen wire testing machines each having capacities of 1,000 and 10,000 pounds. One of the smaller Amsler machines is equipped with a constant load maintaining device of the hydraulic type, and two are provided with automatic electric recording extensometers.





INSTRUMENT SHOP, SHOWING LATHES, SHAPER, SENSITIVE
DRILL PRESS AND TOOL GRINDER

Provision is made for making tensile tests of metals at both high and low temperatures over a range of -114°F to $+1200^{\circ}\text{F}$. Equipment is also available for the calibration of extensometers and strain gages, as well as the calibration of other testing machines. In thoroughly modern instrument shops, equipment and apparatus for both the Research Laboratories and the various plant laboratories are constructed and repaired, and the thousands of test specimens required by the Research Laboratories are prepared on a production scale.



MACHINES FOR MEASURING THE ENDURANCE PROPERTIES
OF METALS

TESTING MACHINES are provided for the determination of the endurance or fatigue properties of metals. This equipment includes 41 R. R. Moore type rotating-beam, 8 constant deflection type of fatigue machines for testing sheet metal, 2 four-specimen direct tension type machines, 1 long specimen Shelton type rotating-beam, and 1 cantilever specimen type arranged for testing aluminum tubing and fittings. In addition, there are fatigue machines for making tests in repeated shear and rotating-beam tests at elevated temperatures. The fatigue strength of alu-

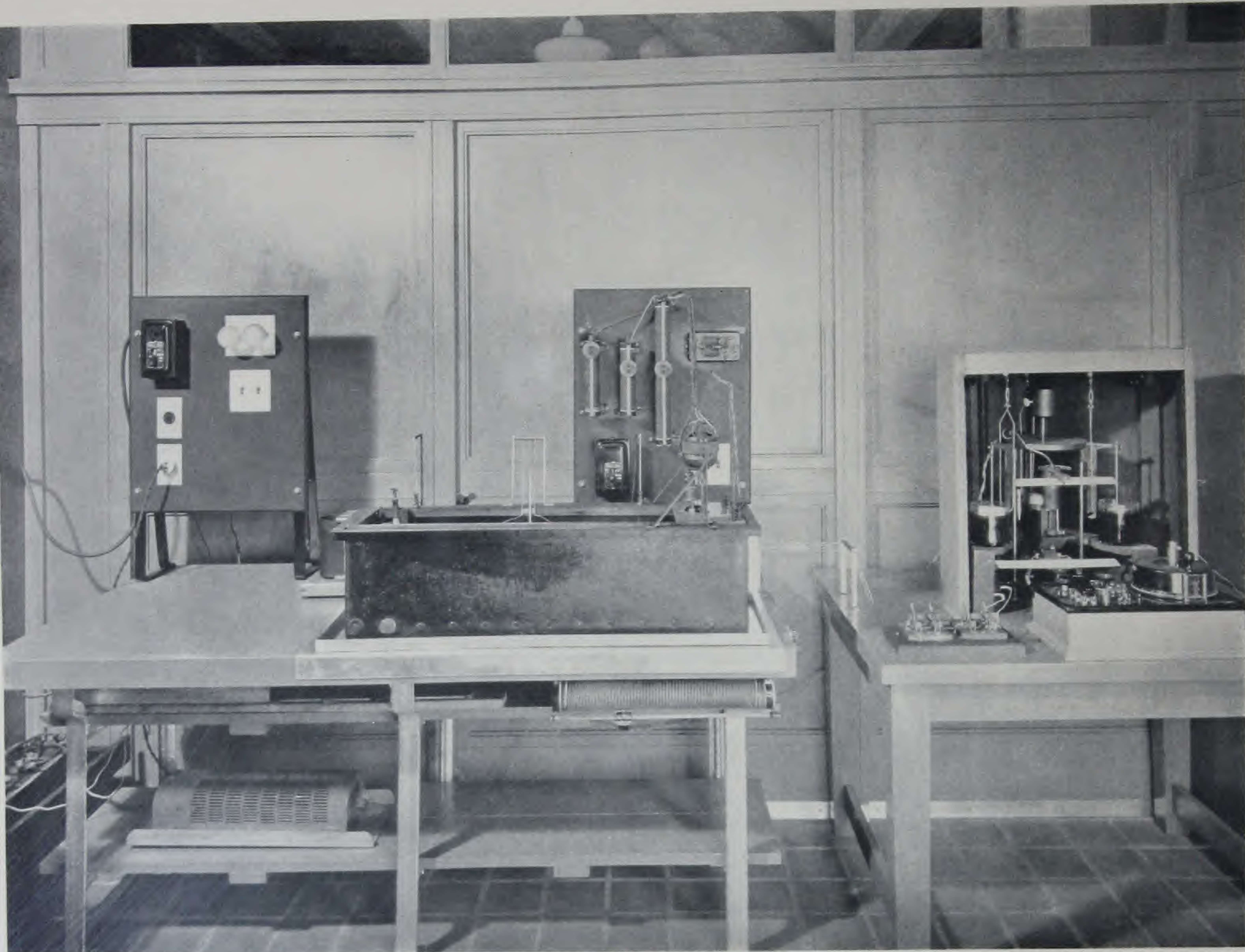




TON WEIGHT READY TO DROP ON ALUMINUM ALLOY BEAM

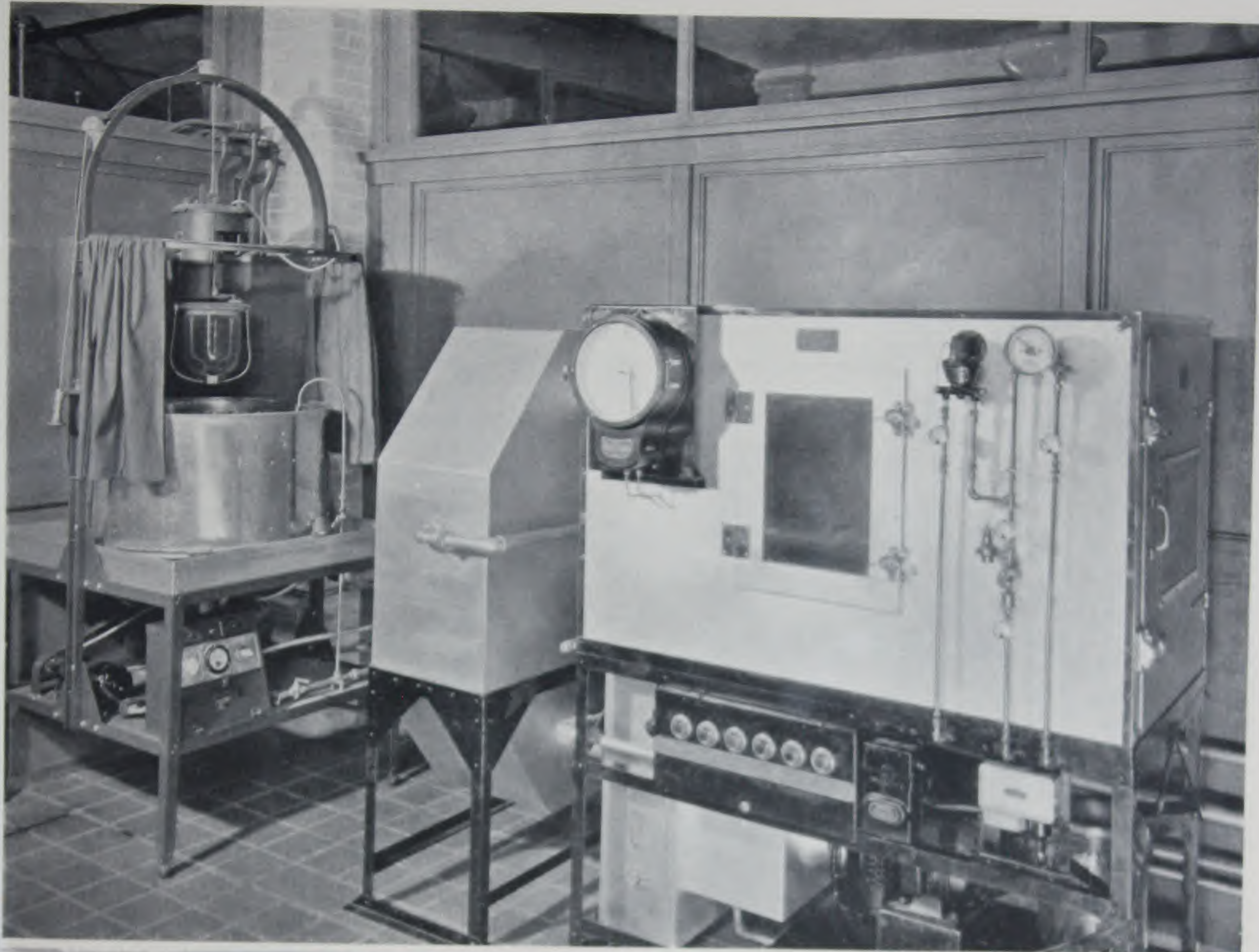
minum based on the material withstanding 500,000,000 cycles of stress.

A universal impact testing machine is provided with tups of 500, 1,000 and 2,000 pounds which can be dropped from any height up to a maximum of 20 feet. Arrangements are provided for testing beams, columns, frames and panels, with recording devices for deflections and strains. Tests are carried out with this machine to determine the ability of aluminum structures to withstand dynamic loads under conditions closely simulating those occurring in service.



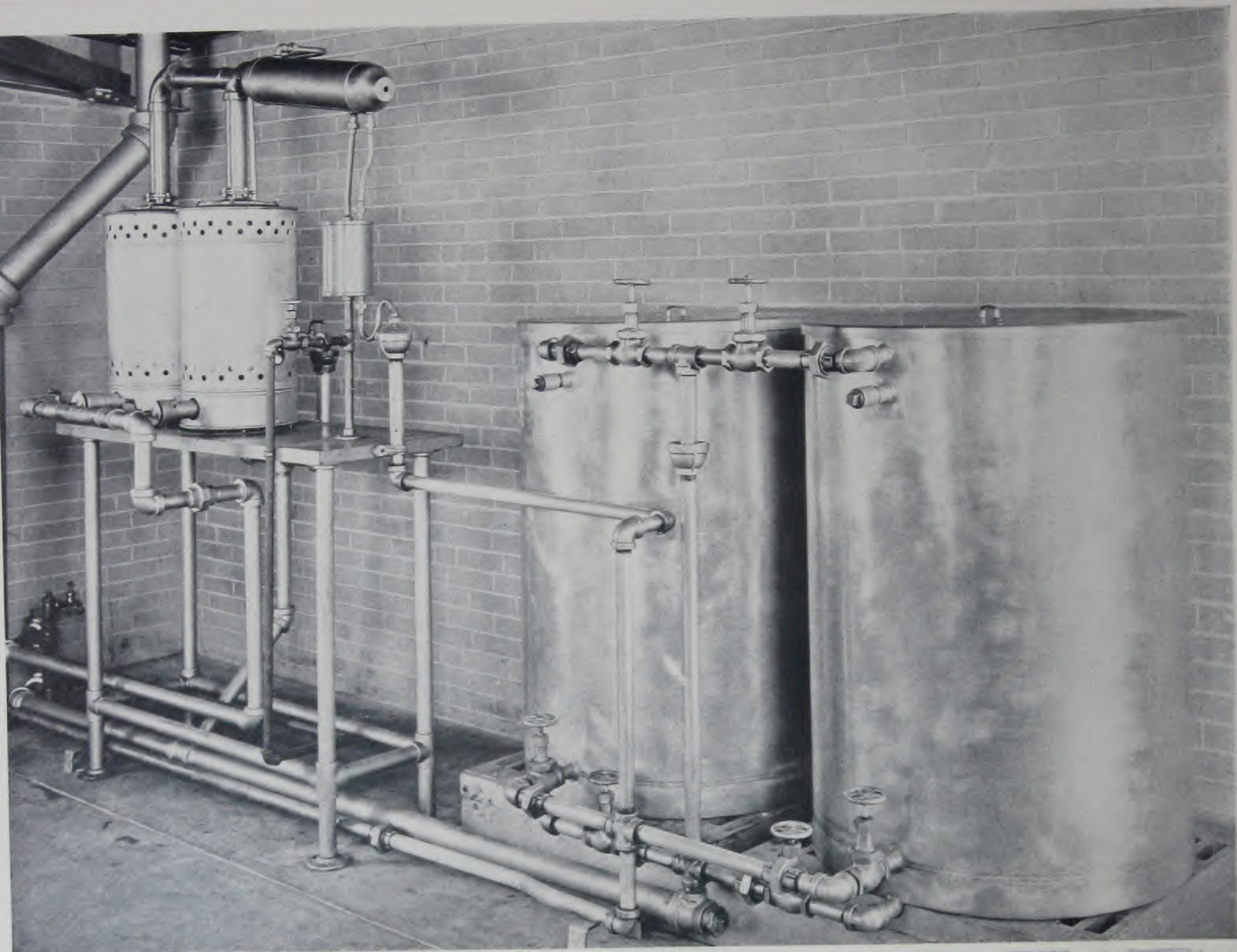
PHYSICAL LABORATORY FOR ELECTRICAL MEASUREMENTS

THE PHYSICAL CHEMISTRY DIVISION is equipped to make precise measurements of such varied properties of materials as conductivity, density of solid and liquid metals, solubility of gases in liquid metals, melting point, density and electrical conductivity of fused salts, etc. Apparatus for measuring thermal conductivity and emissivity is employed in investigating the insulating properties of bright aluminum foil separating thin air spaces. Processes for the production of aluminum reflectors have been developed with the aid of a precision reflectometer.



ARTIFICIAL WEATHER AND CONSTANT HUMIDITY EQUIPMENT
FOR TESTING PAINTS AND LACQUERS

The division of Paints and Finishes investigates the properties and application of aluminum paint, as well as the application of paints and finishes to metallic aluminum. In the painting of aluminum, for example, the investigations include the details of surface preparation, and paint formulation for many applications varying from service on seaplanes to bridges and railway cars, as well as testing of the finish for durability. For determining the moisture-proofing properties of paint coatings, a cabinet with controlled temperature and humidity is employed.



STILL AND ALUMINUM EQUIPMENT FOR STORING AND
DISTRIBUTING DISTILLED WATER

DISTILLED WATER for the laboratories is stored and distributed in aluminum tanks and pipes. Two aluminum storage tanks with the essential aluminum piping and fittings are shown near the stills. This installation is based upon more than fifteen years of satisfactory experience in handling distilled water in aluminum.

The many laboratories illustrated in the booklet are engaged on a wide variety of problems with two general objectives. One is to secure a comprehensive scientific knowledge of the Company's processes and products,





LABORATORY FOR SERVICE TESTS ON ALUMINUM

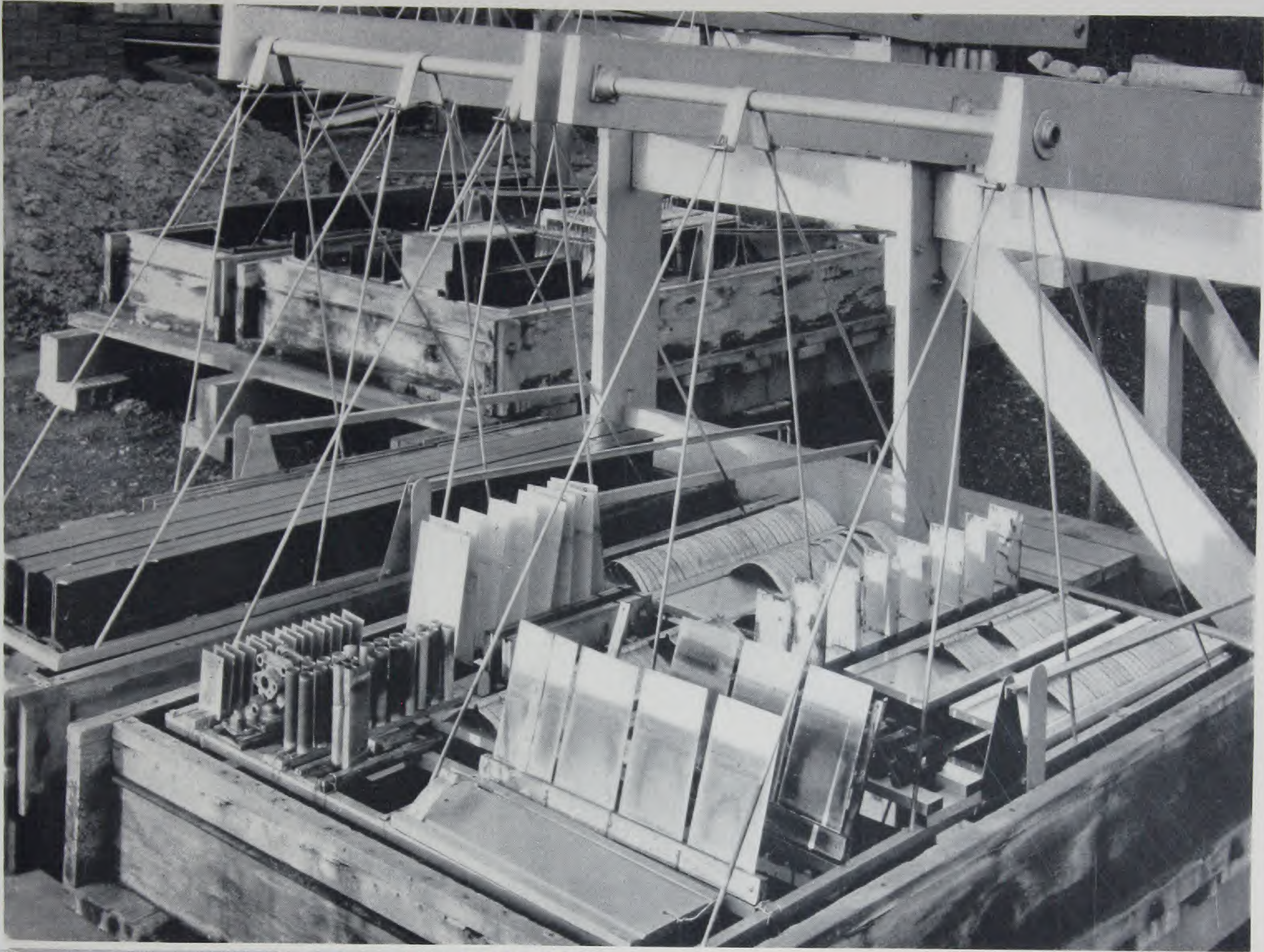
so that present ones may be improved and new processes and products developed to meet or to anticipate the needs of industry. The other objective is to make aluminum more useful to the consumer by providing accurate data concerning its chemical, physical and mechanical properties. The use of aluminum in railway trains or bridges, for example, was made possible by the development of new alloys, as well as detailed data on their structural properties so that the engineer could employ them with confidence.



EXPOSURE TESTS OF PAINTS AND METALS

THE durability of a product, whether it be a metal or a paint finish, is a matter of common interest to both producer and user. The work of the laboratories includes extensive exposure tests of many materials under many conditions. On the roof of the laboratory there are racks carrying hundreds of test specimens which include aluminum and its alloys, bare, painted, enamelled, oxide-coated, etc., for decoration or protection. Among the many paint tests are aluminum painted steel panels which are still in excellent condition after 10 years' exposure.





TANKS FOR IMMERSING METAL TEST PIECES
IN SEA WATER

For comparison with the exposure tests of metals at New Kensington, which represents an industrial location, similar exposure tests are conducted at Edgewater, N. J., Point Judith, R. I., at the seashore, and Georgetown, South America, a tropical location.

On the grounds of the Research Laboratory are located tanks carrying synthetic sea-water in which racks of test pieces are alternately immersed, then raised and allowed to drain and dry. This is an accelerated test under conditions which simulate service conditions in seaplanes, ships, etc.

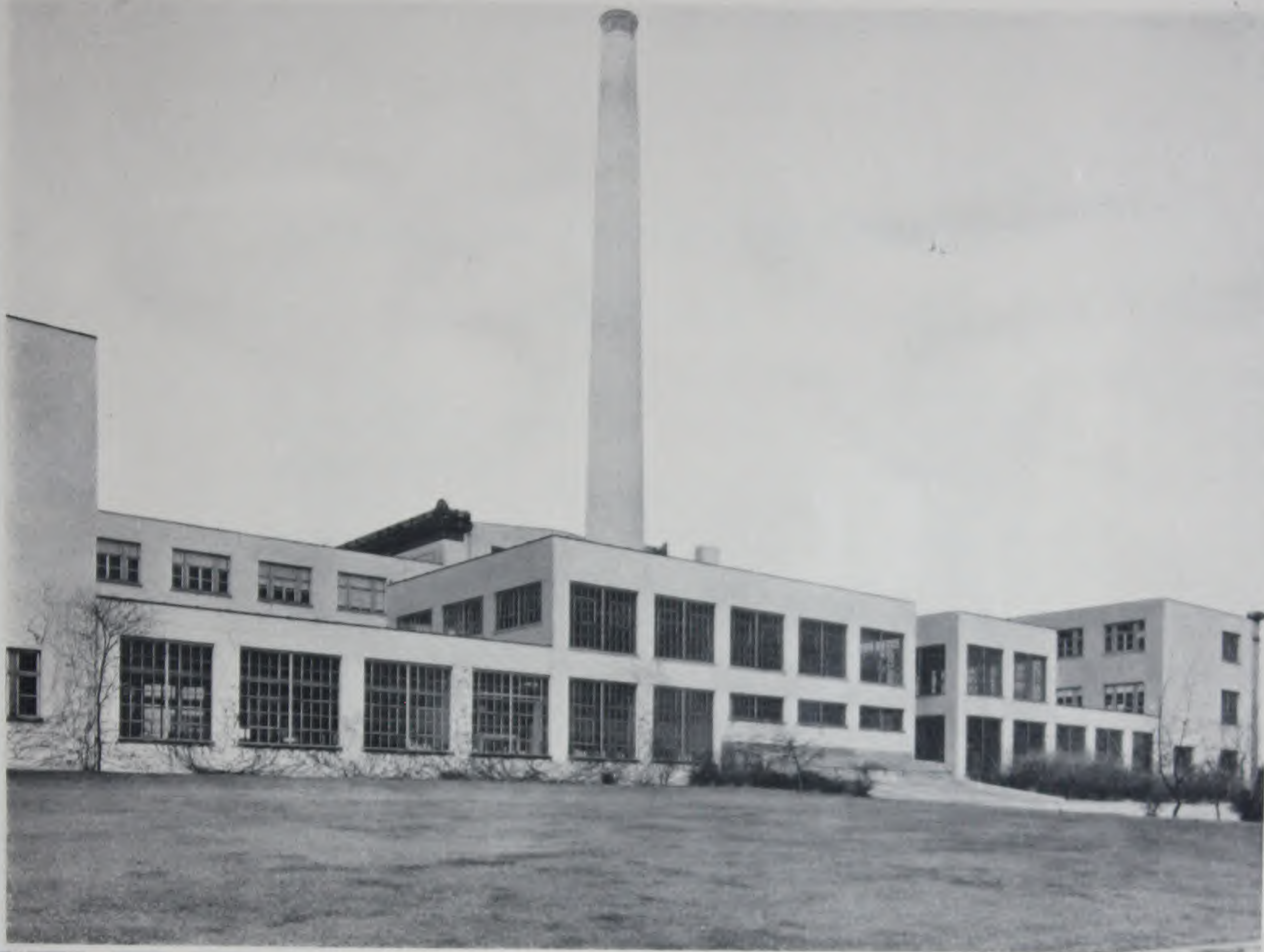


RESEARCH LIBRARY

AN ESSENTIAL TOOL for research work is an adequate technical library. The card index in the library now contains some 100,000 cards covering books, scientific and technical articles, and technical correspondence on subjects of interest to the laboratories. In a separate workroom in the library, the Company's technical correspondence is filed according to subject matter. The drawer pulls and trim on the metal desks and files are of aluminum.

The laboratory is 275' long with 108' wings at each end. At present





REAR VIEW OF ALUMINUM RESEARCH LABORATORIES

it contains 56,000 feet of floor space. On the laboratory grounds are extensive exposure tests of metals and paints, including a test fence constructed with 11 different species of wood siding, which demonstrates the advantages of mill priming with aluminum paint. The rear of the building has been left unfinished from the architectural standpoint. As additional space is required for research work, it is intended to complete the building in the form of a hollow square. The continued growth of the aluminum industry will certainly call for such increased facilities.

ALUMINUM COMPANY OF AMERICA

Sales Offices

Albany, N. Y.	90 State Street
Atlanta, Ga.	1818 Rhodes-Haverty Building
Birmingham, Ala.	1112 Martin Building
Boston, Mass.	20 Providence Street, Park Square
Buffalo, N. Y.	1880 Elmwood Avenue
Chicago, Ill.	520 N. Michigan Boulevard
Cincinnati, Ohio	903 Dixie Terminal Building
Cleveland, Ohio	2210 Harvard Avenue
Dallas, Texas	1601 Allen Building
Detroit, Mich.	3311 Dunn Road
Fairfield, Conn.	Boston Post Road
Hartford, Conn.	Capitol Building, 410 Asylum Street
Indianapolis, Ind.	716 Merchants Bank Building
Kansas City, Mo.	2306 Power & Light Building
Los Angeles, Calif.	1031 S. Broadway
Milwaukee, Wis.	735 N. Water Street
Minneapolis, Minn.	1345 Northwestern Bank Building
Newark, N. J.	1111 Academy Building
New Orleans, La.	1512 American Bank Building
New York, N. Y.	230 Park Avenue
Philadelphia, Pa.	2307 Fidelity-Philadelphia Trust Building
Pittsburgh, Pa.	Gulf Building
San Francisco, Calif.	709 Rialto Building
St. Louis, Mo.	1825 Boatmen's Bank Building
Toledo, Ohio	1315 Ohio Bank Building
Washington, D. C.	606-611 Southern Building

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